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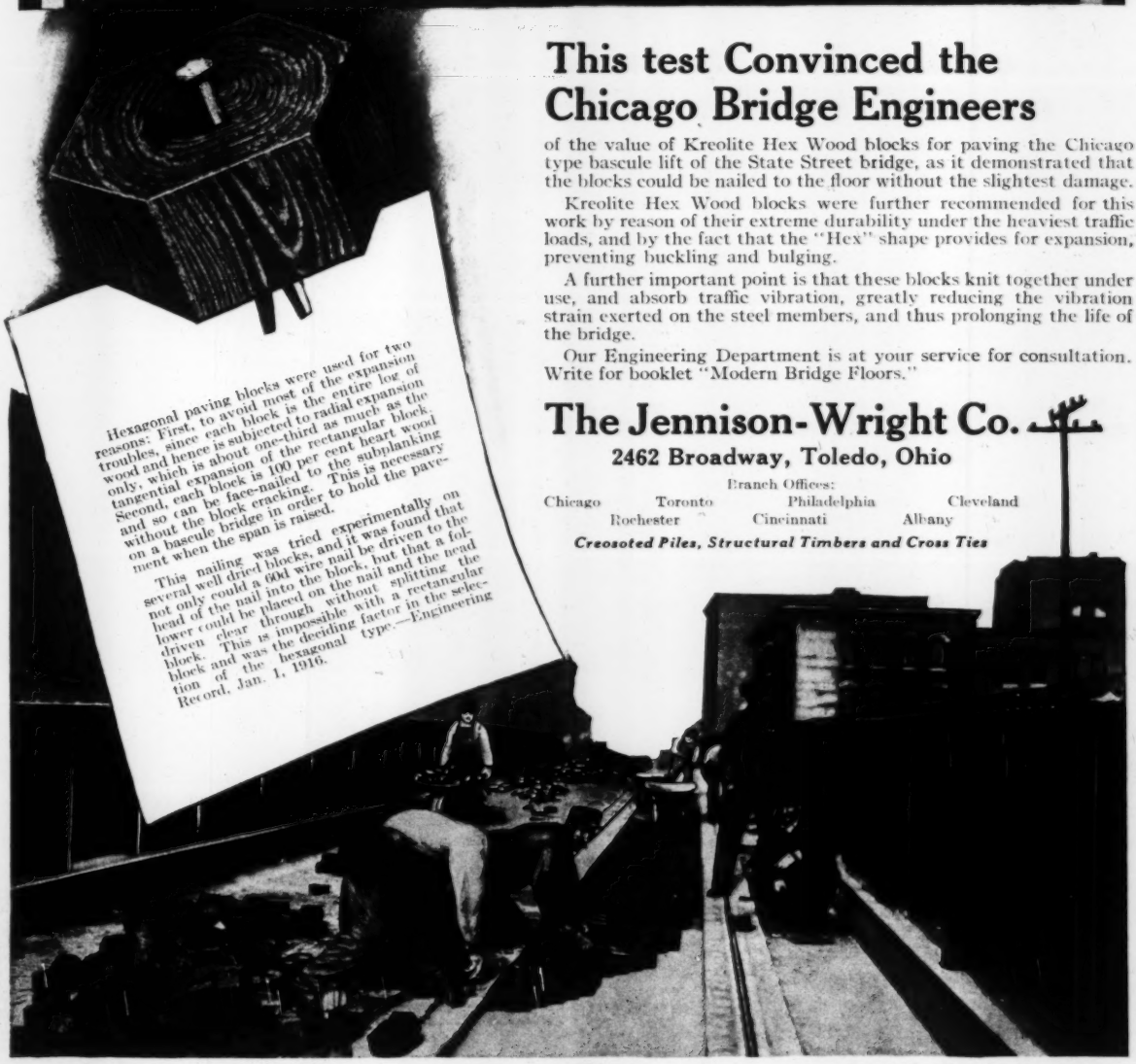
Advertising Index, Last Page

Kreolite Hex
WOOD BLOCK FLOORS
Best for Bridges



Hexagonal paving blocks were used for two reasons: First, to avoid most of the expansion troubles, since each block is the entire log of wood and hence is subjected to radial expansion only, which is about one-third as much as the tangential expansion of the rectangular block. Second, each block is 100 per cent heart wood and so can be face-nailed to the subplanking without the block cracking. This is necessary on a bascule bridge in order to hold the pavement when the span is raised.

This nailing was tried experimentally on several well dried blocks, and it was found that not only could a 60d wire nail be driven to the head of the nail into the block, but that a following could be placed on the nail and the head driven clear through without splitting the block. This is impossible with a rectangular block and was the deciding factor in the selection of the hexagonal type.—Engineering Record, Jan. 1, 1916.

This test Convinced the Chicago Bridge Engineers

of the value of Kreolite Hex Wood blocks for paving the Chicago type bascule lift of the State Street bridge, as it demonstrated that the blocks could be nailed to the floor without the slightest damage.

Kreolite Hex Wood blocks were further recommended for this work by reason of their extreme durability under the heaviest traffic loads, and by the fact that the "Hex" shape provides for expansion, preventing buckling and bulging.

A further important point is that these blocks knit together under use, and absorb traffic vibration, greatly reducing the vibration strain exerted on the steel members, and thus prolonging the life of the bridge.

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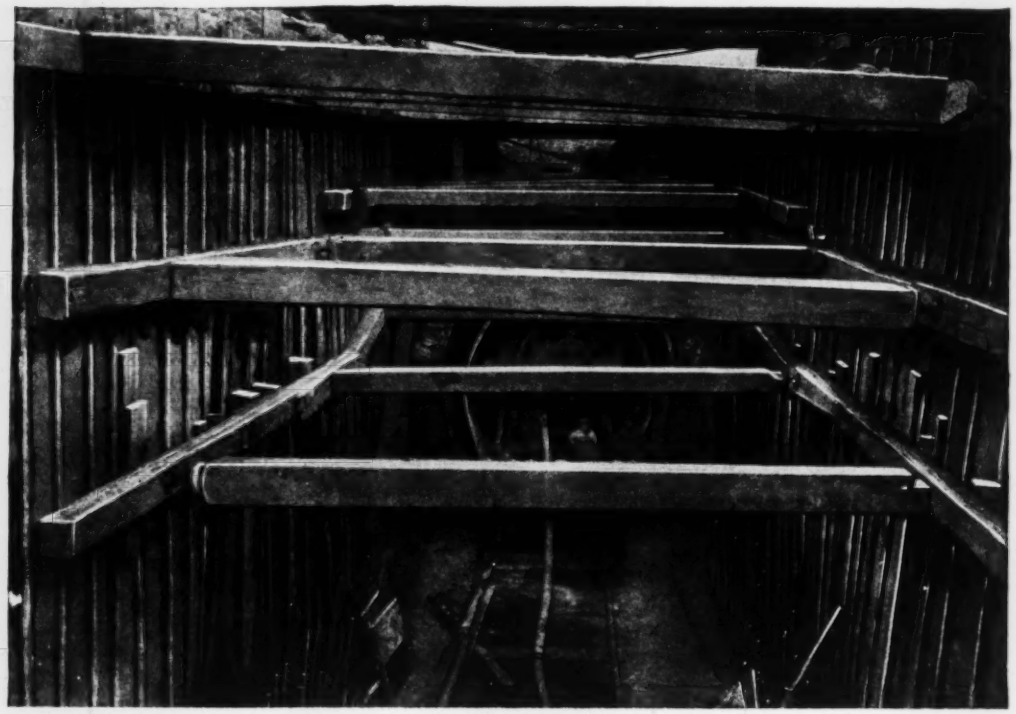
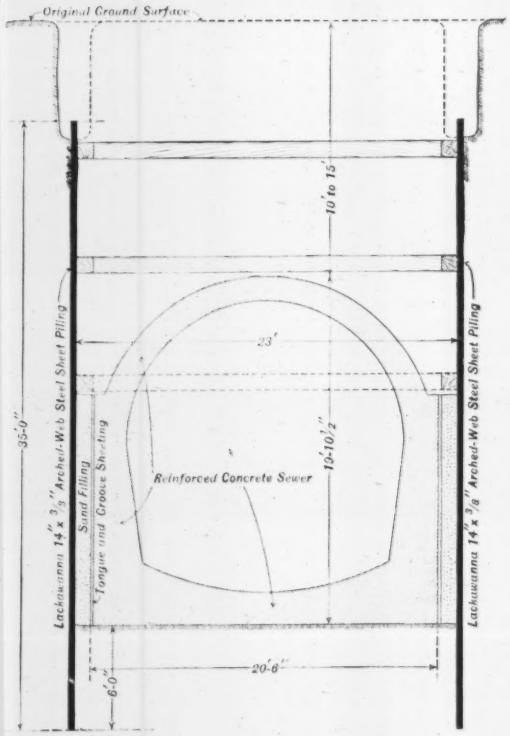


Lackawanna Steel Sheet Piling in the Construction of Mill Creek Sewer, St. Louis



This sewer, of which typical sections are shown, was built through a district where quicksand ten feet under the surface endangered the buildings on either side.

To furnish the necessary protection and to facilitate excavation, the American Contracting Company, St. Louis, originally purchased about 1,000 tons of 14-in. by $\frac{3}{8}$-in. Lackawanna Steel Sheet Piling, with the idea of pulling this steel sheeting and redriving as the work progressed. However, as city officials, particularly Mr. H. S. Owen, Engineer of Construction, realized the desirability of permanent protection against shifting of sewer and adjacent buildings at the most treacherous spots, the city arranged to pay for that steel sheet piling which should be left in place, and altogether now over 1,824 tons of Lackawanna Steel Sheet Piling have been purchased for this work. Most of this will ultimately remain in the ground.

Permanent or temporary constructions of Lackawanna Steel Sheet Piling, properly designed, can be made to show splendid economies. Get our book "Lackawanna Steel Sheet Piling" and ask for the free cooperation of our Steel Sheet Piling Engineers.

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(252)

Engineering News

VOLUME 76 AUGUST 17, 1916 NUMBER 7

Cylinder Pier Foundations Laid Inside Sheetpile Wells

By C. S. Boardman*

SYNOPSIS—In new power house for Buffalo General Electric Co., heavy foundations in low-lying ground were rapidly built by driving cylinder piers of steel sheetpiling, excavating by jet pump and filling with concrete.

With the present prosperous business condition arose the necessity for a greater production of electric power in the Buffalo and Niagara Falls territory. The Buffalo General Electric Co. to meet this demand gave a contract to the Stone & Webster Construction Co. for a steam-generating electric plant to cost more than $3,000,000 and to be erected on a site selected on the Niagara River in the town of Tonawanda, about midway between Buffalo's north city line and the south city line of Tonawanda. This plant will occupy a plot having a frontage on the Niagara River of 1,040 ft. and a depth of 600 ft., and will have railway connection with the New York Central & Hudson River R.R. (Buffalo Industrial Line). In the design and construction of this plant the conditions were: First, the contract called for starting this work in midwinter on ground overflowed with every high southerly wind, the ground level of the property being less than 12 in. higher than the normal flow of the river. The materials lying below the surface of the ground were about 5 to 7 ft. of soft mud and silt, then 25 to 28 ft. of sand or quicksand thoroughly saturated with water from the river; the remaining 3 ft. overlying bedrock was a clay containing quantities of glacial drift composed of large gravel and small boulders. Time of completion was also an essential feature. It was proposed to have this plant under cover and in operation some time during the fall of 1916. With all these conditions imposed, the contractor realized that only a small part of this time could be given to the construction of the foundations, at the same time realizing the loads which would be imposed upon the foundations required that they all be carried to bedrock. The building is approximately 240x 223 ft. in plan, with a floor level about 40 ft. above bedrock and about 5 ft. above river level. The roof is about 100 ft. above floor level, and the top of two sheet-steel stacks is about 114 ft. higher. These stacks are supported by the structural-steel framework of the building.

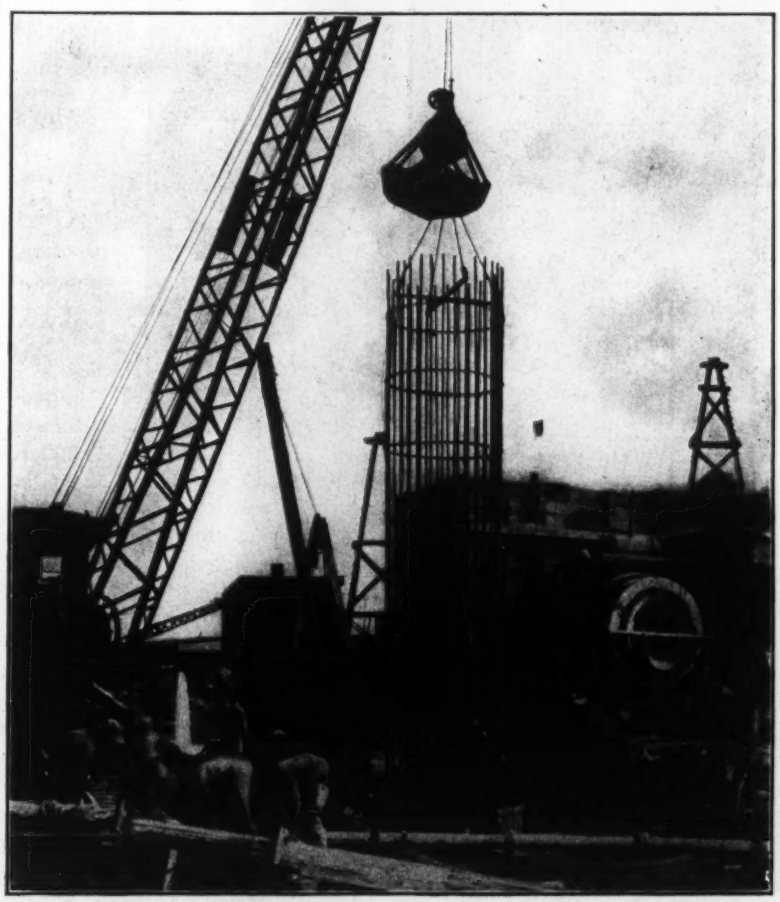


FIG. 1. PLACING THE REINFORCEMENT CAGE IN THE CYLINDER WELL

A series of bore holes developed that bedrock lay almost horizontal and about 35 ft. below the surface of the ground, the materials, as stated, being general over the entire site.

*Chief Engineer, Sheetpiling Department, Lackawanna Steel Co., Buffalo, N. Y.

It was decided to carry all loads upon 157 cylinder piers varying in diameter from 33 to 81 in. The maximum compressive stress allowed anywhere on the reinforced concrete was 500 lb. per sq.in. The larger piers carry as high as 874 tons per pier.

Operations were started almost immediately after the contract had been awarded, and materials were purchased even before the plans could be perfected. It must be remembered that the past winter was a very severe and trying one, even for Buffalo territory. The condition of the market for purchase of materials, the delay in the delivery of most of them, and the freight congestion dur-

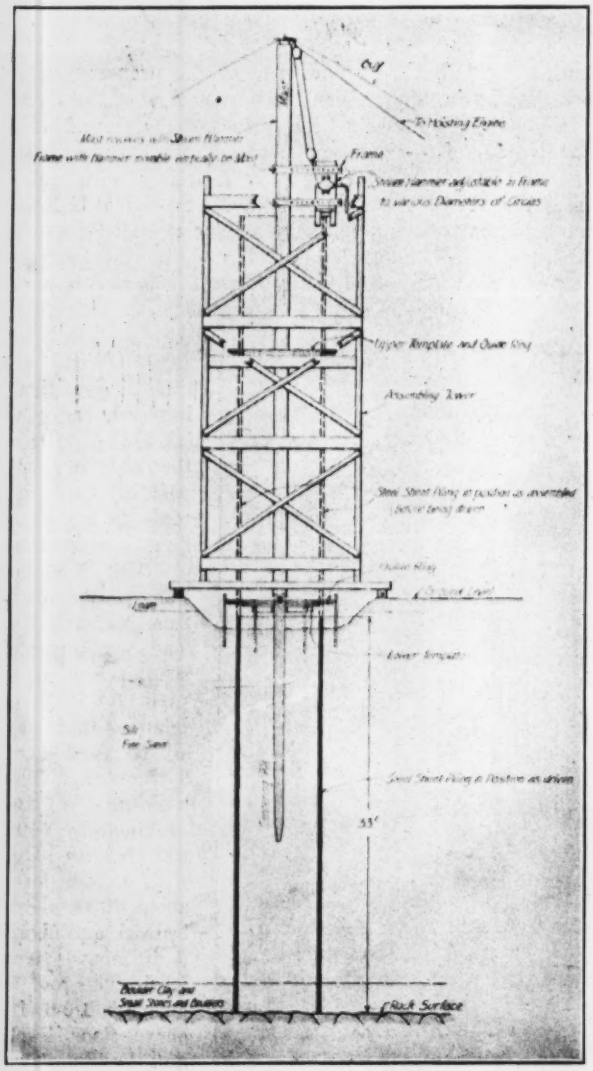


FIG. 2. DIAGRAM SHOWING METHOD OF DRIVING CYLINDERS OF SHEETPILES

ing this period, caused many inconveniences and delays at first.

It was decided to construct these foundations in open cylinder caissons of steel sheetpiling, Lackawanna 12¼x ⅜-in. straight-web and bent-web sections being selected. The first order for piling was placed Dec. 27, 1915, and the material was on the ground about the middle of January, 1916. The cylinder diameters were adopted

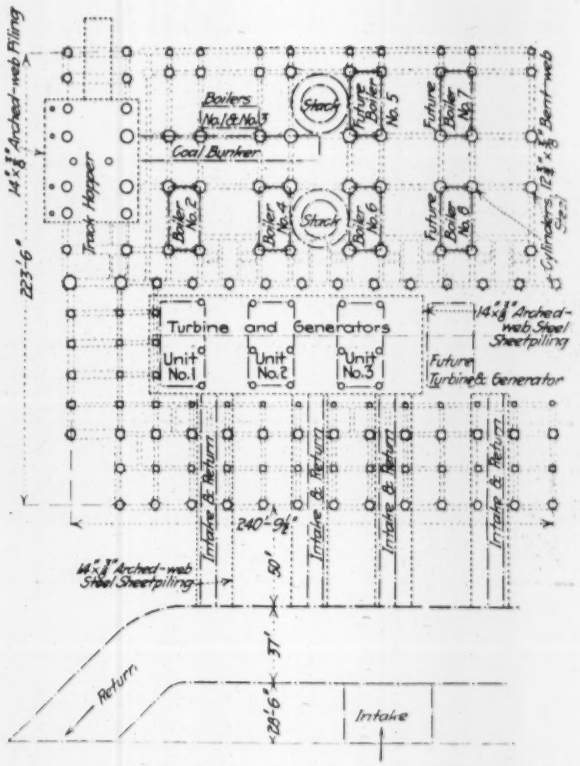


FIG. 3. FOUNDATION PLAN OF BUFFALO GENERAL ELECTRIC CO. ON NIAGARA RIVER

from a table of bent-web piling (compiled by the steel company) as follows:

Number of Piles	Angle of Bend in Web of Sheetpile	Diameter
18	0° straight web (Required no bending)	73 in.
16	4° bent web	5 ft. 4⅛ in.
14	7° bent web	4 ft. 8⅛ in.
12	11° bent web	4 ft. ⅛ in.
10	17° bent web	3 ft. 4⅜ in.
8	26° bent web	2 ft. 8⅞ in.
6	21° bent web	2 ft. ⅜ in.
4	90° bent web	Four 90° bends

Cylinders of 8, 12 and 14 piles of bent-web piling and cylinders of 18 and 20 piles of straight-web piling were used. In these cylinders 1,296 tons of sheetpiling in 33-ft. lengths were used. The piling is to remain permanently in position as part of the structure. The accompanying plan shows the general arrangement and size of the piers, as well as the location of intake and discharge condensing-water tunnels constructed from the Niagara River to each turbine.

The construction of these tunnels required coffer-dams and these were built using 344 tons of Lackawanna 14x ⅜-in. arch-web section in 35-ft. lengths. This piling has been driven and redrawn—by inverted steam hammer—several times during construction of this part of the work, and will be used in extensive coffer-dams required for constructing the intake, etc.

The pier foundation work consisted essentially in driving closed cylinders of sheetpiles, excavating the inclosed material by jetting it out, and filling the opening so left with reinforced concrete.

The construction of these cylindrical piers is novel and original, both in design and execution. Two cableways with two timber portable towers 70 ft. in height built on skids were placed over the center lines of two rows of piers and were used to handle the steel sheetpiling, timber

mast, steam piledriving hammers, wooden assembling towers, etc., as described in detail later. Reference to Fig. 7 will show a general view of this contract on Mar. 25, 1916.

To sustain the loads imposed it was of utmost importance that the cylinder piers should be vertical and located accurately. A timber pile was first driven on the exact center of each pier. These piles were later dressed at the top and a hole bored in the center. Excavation proceeded around this pile to a point near the water level, when the lower templet was set in position and secured to the center pile.

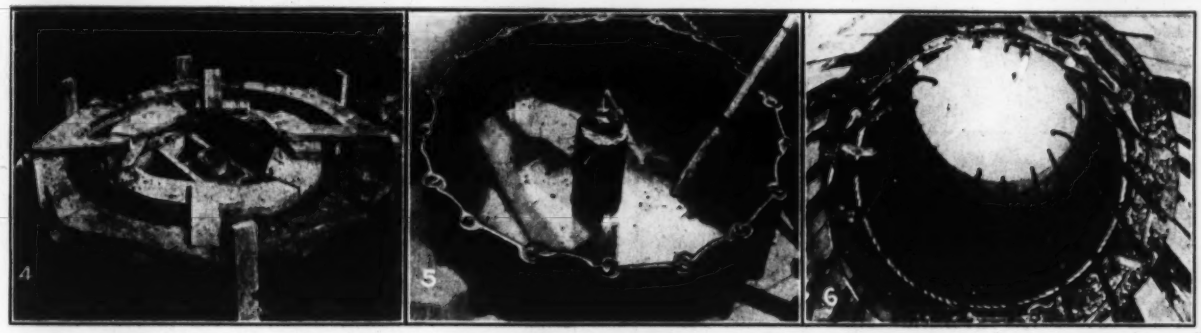
The timber assembling tower (Figs. 2 and 7) was now placed over the lower templet, and the upper templet and guide ring were centered in this tower in correct position over the lower templet.

The steel sheetpiling was now handled by the cableways and assembled one piece at a time around these templets, the cableway being of sufficient height to raise the pieces above the 33-ft. sheeting already assembled, so that the piles could be interlocked at the top. The position of the cableways also permitted all of the piles in one cylinder, or all the cylinders in the row, to be assembled. The greater portion of the assembling was done at night; while the cylinders were driven by day.

This method of assembling allowed the entire cylinder to be set and held vertical, and the closure pile assembled for its entire length. A 14x14-in. wood mast 42 ft. long was then mounted and held in position on top of the wooden pile by a 2-in. steel pin, and guyed at the top by four ⅝-in. wire cables, the mast being free to move within the top templet.

A No. 7 McKiernan-Terry steam piledriving hammer weighing 5,000 lb. was lifted by the cableway and supported from the mast by a steel A-frame so designed as to allow the hammer and frame to slide freely upon the mast. The mast was free to revolve, and the hammer was offset from the mast the required distance to bring it central over the pile walls. The steam piledriving hammer was lowered or raised by a set of double blocks provided on the side of the mast above the hammer, the power line passing over a sheave in the top of the mast to the stationary hoisting engine.

Two sheetpiles were then driven by this steam hammer about 3 or 4 ft. when the hammer was raised and placed upon two adjacent piles, driving them about the same distance. This operation was repeated until the entire circle was driven into bedrock. The average time of driving was about 6 hr. for each cylinder. A greater portion of this time, however, was required to drive the



FIGS. 4 TO 6. SUCCESSIVE STEPS IN THE DRIVING OF THE CYLINDERS
Fig. 4—Guide frame in place. Fig. 5—Sheetpiles driven. Fig. 6—Reinforcement and upper casing in place

FIG. 7. GENERAL VIEW OF WORK DURING DRIVING OF PIERS

piles through the glacial drift and into the disintegrated top of bedrock. Penetration into rock—as closely as can be determined from original borings—was from 6 to 18 in. Six No. 7 hammers were used in this driving.

The work of assembling and driving the cylinders was commenced on Jan. 15 and, notwithstanding the delays caused by severe weather, flooding of the site, and the exposed location, the driving was entirely complete by Apr. 6, or in a total of about 70 working days.

Excavating Materials from Cylinders

A multiple-stage centrifugal pump with a capacity of 1,500 gal. per min. against a pressure of 125 lb. per sq.in. was installed on a timber-pile trestle on the shore of the river. An 8-in. main with a 6-in. distributing

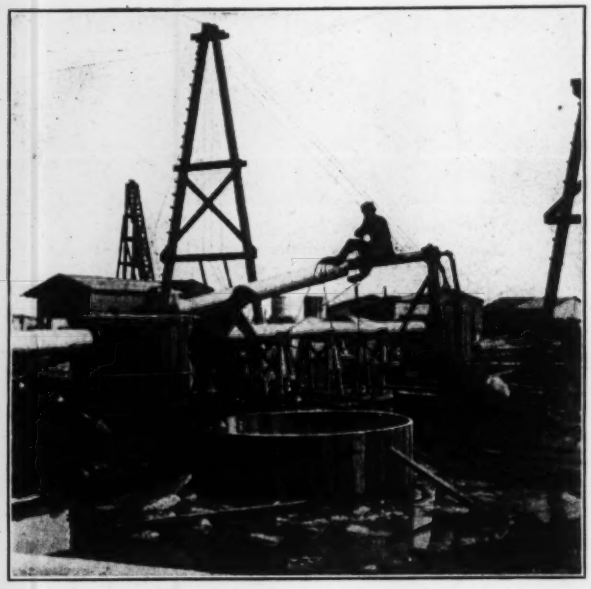


FIG. 8. GETTING OUT THE CONTENTS OF THE CYLINDERS

pipe carried the water close to the cylinders. A sand jet pump constructed with a 6-in. pipe about 40 ft. long, having an elbow at the top, and a right-angle pipe 10 ft. long (with two water jets fastened to opposite sides of this pipe) was used as a water jet pump. The two pipe jets had reducers at the lower end—one of 2½-in. being turned upward and toward the center of the bottom of the 6-in. pipe, the other being straight, 1½ in. in diameter and extending about 12 in. below the end of the larger pipe. These jets had the effect of stirring the sand and forcing it upward through this larger pipe. To complete this pump a 2-in. pipe connection was made in the elbow, directly opposite the horizontal piece of 8-in. pipe. These three jets were connected to the pump by fire hose.

The pump thus assembled was raised by the cableway and stood vertically on the material within the cylinder, the upper end of the 6-in. tube being closed by a gate valve. The water was then turned into the jets, and as the only avenue of escape was through the bottom the pump rapidly settled under its own weight to the bottom of the cylinder. The gate at the top of the pump was then opened and the pressure from the jets caused a large stream of sand and water to be discharged. This method of excavation proved to be so rapid that only 2 hr. was required to remove all the sand and loose material from a cylinder. An independent jet was used to clean the sand and material from near the walls of the cylinder.

Circular wooden forms were bolted to the top of the steel cylinders to permit the spoil to be used to raise the general ground level.

Excavating Overlying Materials and Cleaning Bedrock

To remove hard clay conglomerate or heavy gravel and boulders remaining in the cylinder after the finer material had been removed, a 14-in. arch web sheetpile 35 ft. long, weighing 1,425 lb., was hung inside and used as a vertical battering ram until the hard formation was broken up so that it could be removed by a small orange-peel bucket. The final operation in cleaning bedrock inside the cylinders was to replace the large jet pump and to carefully wash the rock by means of 2-in. jets—one operating vertically, the other horizontally. The degree of cleanliness of the bottom was tested carefully with a sounding rod.

Concreting the Foundations

After inspection had proved that the rock was clean and ready for concrete, the jet pump was removed and a cage of reinforcing steel, previously assembled, was lowered (Fig. 1) into the cylinder. These steel cages were provided with stub guides which held them in proper position relative to the sheetpiling forming the cylinder shelves.

A portable concreting plant was employed, traveling on railway tracks. This plant, consisting of a flat-car

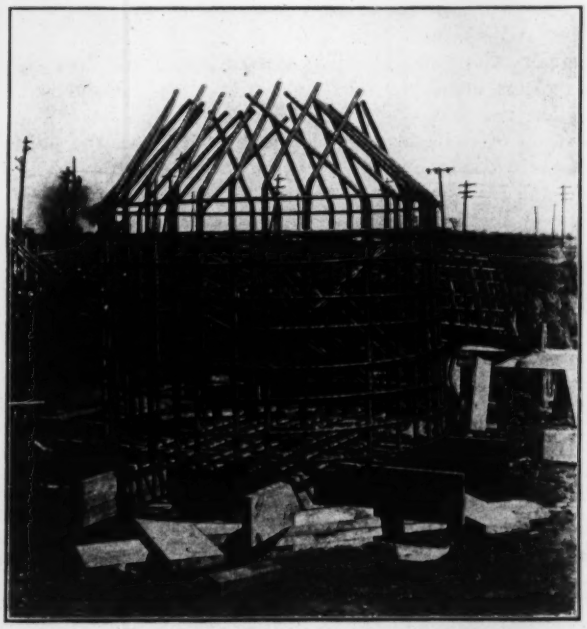


FIG. 9. NEAR VIEW OF A REINFORCEMENT CAGE FOR THE TOP OF PIER

equipped with a wooden hopper and a 1½-yd. mixer with loader, was placed at a point convenient to the cylinder to be concreted. Concrete was chuted to the hopper of an ordinary tremie pipe which deposited it on the bottom. The tremie was hoisted and sections of it removed as the level of the concrete rose. The lower end of the tremie was maintained from 1 to 2 ft. below the surface

of the concrete. This tremie was operated with extreme care so as never to lose its seal in the concrete nor its charge of concrete.

By this method each cylinder was filled with concrete to a point 2 to 3 ft. below the top of the sheet-piling and after allowing sufficient time for the concrete to set, water was pumped out of the top to the level of the concrete, and the laitance (usually 2 to 3 in. deep) was removed.

The wooden forms were now placed upon the form for the cap of the pier and the reinforcing bars required for the floor-beams were placed in position and all concrete for top and caps was placed at one pouring.

This work was designed by the Stone & Webster Engineering Corporation, Boston, Mass., and executed by the Stone & Webster Construction Co.; George O. Muhlfeld, Construction Engineer, S. L. Shuffleton, Western Manager, in charge, and E. C. Macy, General Superintendent. H. G. Stott was Consulting Engineer for the Buffalo General Electric Co.

Venturi Meters Inaccurate on Lively Lines

By Allen Hazen*

When there is a steady, uniform flow through a venturi meter, the coefficient of discharge—that is, the ratio which the actual quantity of water bears to the theoretical quantity—is very high and for practical purposes may be taken as 0.99, with a small variation either way. But venturi meters are often used on pipe lines where the flow is not uniform. If the variations are gradual from hour to hour, or even from minute to minute, the apparatus that is ordinarily used will sum up the total flow with accuracy. If, however, the variations in flow are rapid, so that there are substantial changes in rate in a single second, an error may be introduced. This error may be one of considerable importance on lines carrying water directly discharged from reciprocating pumps or from a reservoir into a system where wide and sudden fluctuations in rate of draft are taking place.

A number of circumstances tend to increase this fluctuation. Among them may be mentioned a relatively short discharge line, air chambers that are too small or not adequately connected with the pipes and a high degree of elasticity in the material of the pipe. Steel pipes are more elastic than iron pipes, and there is apt to be more jump or vibration with changes in rate through them. A lively line, for which considerable errors may be anticipated, may be defined as one on which a pressure gage connected to the line wide open will show considerable and rapid fluctuations.

The theoretical reason for the error is that the venturi recorders in reality sum up the squares of the flows. In other words, the flow is averaged by squares instead of directly. The height of the mercury column that is the starting point in the registration is proportional to the square of the velocity.

To take an extreme case, suppose that for half a second the velocity is nothing and for half a second it is 2 ft. per sec. For the whole second the average velocity will be 1 ft. per sec.; but the height of the mercury columns will tend to be for the first phase 0 and for the result corresponding to the average height of the mercury column, which is 2, and the quantity indicated will be the square root of 2, or 1.41, in place of the true quantity, which is 1. In this case the error of over-registration will be 41%.

This merely illustrates the way in which the error is produced. An actual error as large as 41% is not to be anticipated in any case. However, with very lively lines errors of 2% or 5% or even 10% or more may be anticipated, depending upon the liveliness of the line. The error will always be in the same direction—namely, the registration will be above the truth.

In *Engineering News*, July 31, 1913, there was a discussion in regard to the coefficients of venturi meters, in which the writer took the stand that the coefficient of 0.99 should be used in place of the lower coefficients that had frequently been used by makers of venturi apparatus. The thought now occurs to him that in reality the use of these lower coefficients was the outgrowth of practical experience with venturi meters placed beyond reciprocating pumps where over-registration had actually taken place, and the logical result of this condition was for the maker of the meter to use a lower coefficient, which would give more nearly correct results for those particular conditions. The writer now believes that the best procedure is to use the coefficient 0.99 for all cases of steady flow, which is the standard condition. For lively lines the coefficient will be less and will be variable, depending upon the degree of liveliness.

It may be doubted if any data can ever be secured to make possible strictly accurate measurements on very lively lines. In many cases the errors on such lines will be within such limits that the meter will remain an invaluable instrument. In such instances a correction, to be ascertained as accurately as possible to meet local conditions, may be used.

So far as the writer's experience goes, the percentage error with lively lines is very much greater at low flows than at higher flows; the source of error was first brought to his attention in using the venturi meter as a means of checking up the minimum rates of flow into a completely metered system in the early morning hours, when there would normally be little use. The meter was found to over-register for these conditions as compared with the strokes of a pump to an extent that could not be accounted for, although the meter was known to register with approximate accuracy for the higher rates of flow that occur during the day.

It may be pointed out that the errors in the venturi measurements resulting from rapid fluctuation in velocity also occur with the pitometer or standard orifice or any other method of measuring water which depends upon the effect of velocities upon pressures. These studies indicate the need of some new and better apparatus for integrating flows of venturi meters, pitometers and other instruments on lively lines.

*Of Hazen, Whipple & Fuller, Consulting Engineers, 30 East 42nd St., New York City.

The Total Lumber Cut in the United States in 1915, according to statistics published by the United States Forest Service, was 37,013,294 M ft. More than one-third of this was yellow pine, the total cut of which was 14,700,000 M ft. The cut of Douglas fir was 4,431,000 M ft. Of oak, white pine and hemlock, a cut of between 2,000,000 and 3,000,000 M ft. was reported for each. Of spruce, Western yellow pine and cypress, the cut was between 1,000,000 and 2,000,000 M ft. The cut of all other varieties of timber was below 1,000,000 M ft.

Analytical Study of Garbage, Rubbish and Ashes

The report of Irwin S. Osborn, consulting engineer, Cleveland, Ohio, to the Commissioners of the District of Columbia, on the result of his investigation of the collection and disposal of municipal wastes in the District, contains a mine of valuable information. From this report the following abstract has been made for the purpose of showing the scope of the investigation, an outline of the data necessary and the methods of accumulating these data; this being a field of engineering investigation which as yet has received scanty attention from municipal officials and engineers.

Purpose of the Investigation

The studies were made in order to arrive at definite conclusions as to what would be the most feasible plan or method to be adopted, from sanitary and economical standpoints, for the collection and disposal of municipal wastes in the District of Columbia. The following were the principal points embraced:

1. Inspections of all sections of the District with reference to topography and plan, and their influence on collection.
2. Population studies with reference to past growth, sectional growth and estimated future growth.
3. Studies of the present method of collection, with reference to improvement in methods, from the standpoint of sanitation and economy.
4. Time studies of present methods of collection with reference to time required for the several functions of collection.
5. Inspection and studies of quantities produced during the time of investigation.
6. Preparation of maps and tables showing the population in small unit areas.
7. Preparation of tables showing the estimated production of several classes of waste in each unit area.
8. Tables giving the length of haul for each class of waste to assumed points of disposal; from which the estimated cost of collection for any year could be computed for each class of refuse by any method of collection or disposal.
9. Mechanical analysis of rubbish and ashes, to determine the component parts and the proportion of each.
10. Laboratory tests of the component parts of ashes and rubbish from samples taken at the time of mechanical analysis, to determine the calorific value.
11. Chemical and calorific tests of representative garbage samples to determine the percentage of fertilizing elements, fats, solids, combustibles, moisture, calorific value and percentage of ash.
12. Chemical and calorific tests of sectional garbage samples, to determine seasonal variations, the influence of the character of population, etc., on the percentage of fertilizing elements, fats, etc.
13. Inspection and studies with reference to suitable locations for disposal plants and transfer stations.
14. Inspection of all plants operated by contractors for the transfer or disposal of wastes, with reference to their adaptability to the work and to improvements.
15. Inspection of equipment used by the various contractors and investigations into the practicability of improved equipment with District conditions.
16. Comparison of available data with that of other cities, with allowance for variation in local conditions.
17. The applications of the studies made to a large number of projects, assuming certain points for disposal or transfer stations which might become available for the purpose. These data were classified under the following subheads:
    a. The territory or collection district which would be the most economically served by various assumed disposal or transfer stations.
    b. The population to be served in each established collection district.
    c. The estimated quantities of each class of waste produced from each collection district.
    d. The estimated maximum quantity of each class of waste produced during the season of maximum production in each collection district, in order to determine the various plant capacities.
    e. The final capacities of disposal plants for each district, based on the estimated maximum production for the year 1925.
    f. The ton-miles haul for each class of waste, based on the estimated production for the year 1925.
    g. The estimated cost of collection for each collection district and for various methods of collection, based on the estimated production for the year 1925.
    h. The estimated capital costs for each project.
    i. The estimated operating cost for each disposal plant based on the production for the year 1925.
    j. The estimated annual revenues for various methods of disposal, based on the production for the year 1925.
    k. The estimated fixed charge for interest and depreciation.
    l. The net annual cost for each project.
    m. The estimated annual per capita cost.

Division of District Into Unit Areas

In making the studies and investigations, the entire District was divided into unit areas, which were used as a basis in making all collection and production computations. The various items pertaining to the collection and production of refuse for the several projects were deduced from each unit area. The totals for each unit area in all cases were reconciled with authoritative records for the entire District covering the item under study.

The unit areas were based on the present garbage routes, as accurate data were available covering the production in each unit area for past years. In assuming unit areas for future collections, only the natural and topographical areas which would receive service were taken. Tables were made showing the actual amount of garbage collected each day from each unit area, which were used in estimating the future production of garbage in the various sections of the city.

The population of each unit area was taken and the production per 1,000 population determined. This production per 1,000 population was taken as a factor to be multiplied by the population for the different periods.

The estimate of future production of garbage was figured in five-year periods up to 1940, in order to provide plant capacities and estimates for the various years during the anticipated life of the disposal works.

Studies of Collection Methods

In connection with the collection of garbage, sixty complete time studies were made in order to determine the time required for the various steps entering into collection, as well as to determine the time required for each step under varying conditions.

The time studies also take into account the number of houses visited, and, at the same time, the number of houses from which collections were made, so as to determine the percentage of houses receiving service, as well as the average number of receptacles handled. Determinations were also made as to the amount of time required in loading and the time required in hauling after the load was placed on the wagon, so as to estimate the cost of service from the standpoint of loading as well as haul.

Sampling the Garbage

During the year in which investigations were made, general samples were taken periodically every fifteen days, and the garbage submitted to the Department of Agriculture, Bureau of Soils, for making mechanical and chemical analyses.

All samples were taken from the wagon as they arrived at the transfer station. In drawing samples from the

garbage tanks, a sample was taken from each tank on a specified wagon, the samples being drawn from approximately one-third of the wagons in service on each day a sample was taken. The wagons were specified in order that the samples would be drawn from different sections of the city, so as to insure a representative sample.

Each wagon tank was inspected to determine whether the material in all parts of the tank was of the same general character before drawing a sample from any part, and when the sample was drawn it was taken from such sections as would give the average of the full tank. Approximately 1 cu.ft. of garbage was taken from each tank.

The total amount removed from all the wagons was placed on a water-tight platform in a transfer station yard, where it was thoroughly mixed and chopped fine. The total was then divided into quarters, three-quarters being discarded, and the remaining quarter being thoroughly mixed and chopped in quarters. This procedure was repeated until the resultant sample was reduced sufficiently to fill three 2-qt. jars. The jars after being filled were sealed and sent to the Bureau of Soils for analysis. The material from each jar was analyzed so that three analyses were made of the same general sample, in order to check results.

The garbage was analyzed for the percentages of moisture, combustibles, ash, ether extract, potash, phosphoric acid and nitrogen, as well as for its calorific value.

Samples for Sectional Classification of Garbage

In addition to the regular samples which were taken as an average of an entire day's collection, the District was divided into sixteen sections as nearly as possible, according to the classification of people, such as the wealthier, intermediate and poorer classes. From these sections, samples were drawn in a similar manner to that described in drawing the regular samples, and these were analyzed.

All told, 131 sectional samples were taken, the samples being drawn each week so that a sample from each section was analyzed every month. In making up the sectional samples, a part was taken from each load collected in that section from which the sample was to be taken, so as to eliminate any local variations. At the same time, special places such as hotels, the War College, Navy Yard, etc., were omitted in order to get a representative sample from the residences.

The object of taking the sectional samples was to determine, if possible, the variation in the quality of the garbage produced by the different classes of people, as pertains to the value of fats or fertilizing elements contained in it. From the elaborate tests and studies made, curves were plotted and the various elements determined by analyses, and the analyses studied.

Study of Rubbish and Ashes

Tables were made giving the results of the weight and volume studies covering a considerable period of time. At regular intervals mechanical analyses were made of the rubbish for the purpose of obtaining the quantities of the different constituents making up this class of municipal waste, as well as the products which have a commercial value. Special wagons were sent out for collecting the samples, taking a number of houses out of each collection route, so as to get a representative sample of the day's collection.

A representative sample of each component part of the rubbish which contained combustible material was sent to the Bureau of Mines in order to determine the calorific values. The results of the tests constitute the first data available in regard to the calorific values of the various constituents of rubbish.

During the investigation forty-four time studies were made on the rubbish wagons. These were carried on to the same detail as those described in the collection of garbage, and the time required for each function of the work in connection with the collection of rubbish taken into account. The results were used in checking up the costs for the various steps in making the collections and delivery of material.

The estimated future production of rubbish was computed in the same way as for estimating garbage production. The quantities produced per capita in the various sections of the city were applied to the unit areas, so as to determine as nearly as possible the quantities produced in each unit area.

Study and Tests of Ashes

The records of the amount of ashes collected by the contractor were furnished by the District Street Cleaning Division. At regular intervals mechanical analyses were made of typical loads of ashes collected from the several districts and the results plotted.

Samples for calorific tests were made at regular intervals from the various collection routes for the purpose of obtaining the fuel value of the ash in connection with the incineration of other classes of waste collected in the District. Samples were taken by screening the load as it arrived at the point of disposal, using a 3/8-in. mesh screen.

The material collected by the screen was classified as cinders, and that which passed through the screen as dust. A representative sample of the cinders and dust was then sealed and sent to the Bureau of Mines for analysis, where the following factors were determined: Moisture; volatile matter; fixed carbon; ash; B.t.u. in material as received; B.t.u. in material on dry basis.

At regular intervals twenty-eight time studies were made on the ash-collection wagons. The time studies for ashes were carried out in the same manner as described for the collection of garbage. The time required for each function of the work was taken into account and the results used for checking up the costs of the various steps in making the collections and delivery of the material.

Studies of Combined Refuse

From the results and quantities obtained for the separate collection of garbage, ashes and rubbish, tables were developed giving the total estimated pounds of refuse collected per capita per annum, of all three classes of waste. Tables were made giving the estimated future quantities of combined waste to be collected and disposed of, as well as tables giving the quantities of combined waste by volume and weight, as collected during the maximum and minimum months. From these tables estimates were made of collection equipment and plant cost, considering all three classes of waste combined. A second article will give the results of these studies.

Sewage-Treatment Plant, Cook County Institutions

By Burton J. Ashley*

When the Poor Farm for Cook County, Illinois, was moved to Oak Forest in 1911, a sewage-treatment plant was built consisting of two tanks 10x80 ft. in plan by an average water depth of 7 ft., followed by four contact beds 40x40x4 ft., operated by four 5-in. Miller siphons. Five feet from the inlet end of each tank was a baffle wall, extending from the floor upward to a line 12 in. below the water line. At the floor line of each baffle wall were two 12-in. square openings. Within 5 ft. of the outlet end of each tank was a baffle that extended from the floor of the tank to the top with openings at the flow line.

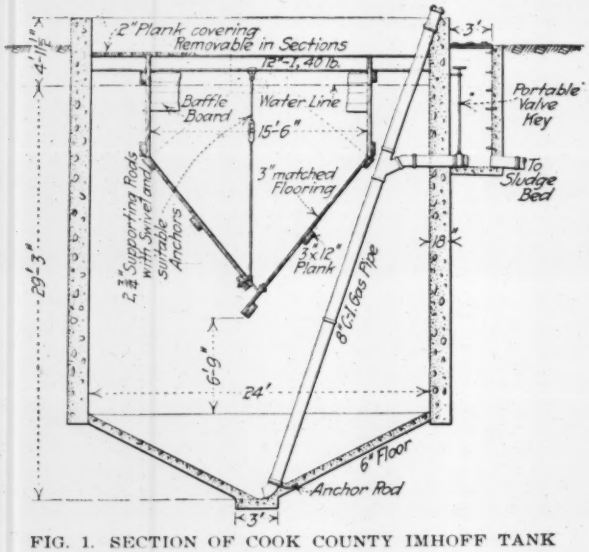


FIG. 1. SECTION OF COOK COUNTY IMHOFF TANK

The duty required of this plant was to serve from 1,800 to 2,800 persons. Storm water from the new buildings was supposed to be excluded from the sanitary sewers, but connections had been made to such an extent as to cause the plant to be deluged during heavy storms. Judging from observation and hearsay evidence, these tanks never became positively septic.

The effluent from the old plant became so serious a nuisance and menace to the farmers below the Poor Farm, through whose farms the effluent flowed, that legal action was taken by the farmers to compel the County Commissioners to abate the nuisance.

About this time, the County Commissioners concluded to build a $1,000,000 County Tuberculosis Sanitarium on the Poor Farm. Consequently it became necessary to rebuild and enlarge the sewage-treatment plant.

The ultimate occupancy of both institutions, including employees, was estimated to be 5,000 persons. The plant designed and built to meet the present and future demands includes: A screening and detritus chamber; Imhoff tank; hypochlorite plant; doubling the area and capacity of the old contact beds, using eight 5-in. Miller siphons in two control chambers, and a sludge-drying bed.

The screening chamber was of the ordinary box type, 2x10 ft. in plan, with a water depth of 4 ft., and provided with ⅜x1-in. bar screens set ½ in. apart.

*Engineer, Morgan Park, Chicago, Ill.

The Imhoff tank (Fig. 1) is circular in main plan, with a rectilinear flow chamber 15½ ft. wide. The cover was depressed as shown to afford more ready access to the scum chambers when cleaning them.

An attempt was made to complete the excavation for the Imhoff tank and then to build the walls within the excavation, but this plan was a failure. The "dig and sink" principle was then successfully adopted by using a circular T-bar heavily anchored in the concrete wall as the cutting edge and by reinforcing the walls themselves. The reinforcement consisted of ¾-in. rods set diagonally 12 in. apart.

The hypochlorite plant was built directly above and upon the inlet ends of the two old tanks and receives the Imhoff effluent, it being the intention to use the south tank as a sedimentation chamber after introducing the hypochlorite into it by means of an orifice box and mixing channel. The inlet end of the old south tank was reconstructed and made into a mixing channel by introducing baffles projecting into the tank from each side wall, thus causing the Imhoff effluent to pass in a sinuous course for the distance of 20 to 25 ft. before being discharged into the sedimentation tank (the old south tank). The hypochlorite is introduced at the inlet end of this channel.

A bypass has been provided so that the discharge of the hypochlorite from the orifice box can be made directly to the outlet sewer from the contact beds by merely opening a valve in the hypochlorite house.

The four old contact beds were duplicated, thus doubling the nitrifying capacity. The material in the old beds, consisting of a 2-ft. layer of 2-in. stone covered with a 2-ft. layer of ¾-in. size (Fig. 2), was wheeled out and washed by passing it through a flooded concrete mixer. This method proved a most unqualified success. The cost of washing and replacing this material was about 45c. per cu.yd. The material was automatically rescreened as it was dumped from the mixer and wheeled back to place.

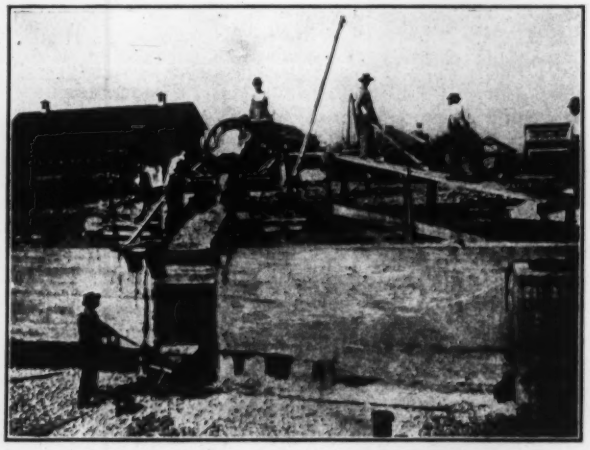


FIG. 2. CLEANING CONTACT-BED STONE IN CONCRETE MIXER, COOK COUNTY, ILLINOIS

The fluid chambers of the control houses being approximately 80 ft. apart were connected by a 12-in. cast-iron water main and the siphon-control pipes in the two houses by 1½-in. air pipes running from one control house to the other on the top of a concrete dividing wall which separates the contact beds.

Each control house was built of concrete and provided with a roof ventilator and a small window. The doors

were made practically frostproof after the character of refrigerator doors.

The filling of one unit of the beds at the time of starting the plant occupied about 50 min. on the average. The siphon mechanism was timed for holding the beds full 1 hr., empty 1 hr., resting empty about 3 hr.

The sludge bed has an area of 2,000 sq.ft., a 1-ft. filtering depth, and consists of cinders with agricultural tile underdrainage.

The nuisance along the farms spoken of was abated immediately on beginning use of the plant in October, 1914.

The plant was designed by the writer, and its construction was supervised by G. A. Freeburg. The contractor was J. J. Croake & Co., Chicago. The contract price was $25,000.

Earth-Road Maintenance in Irrigated Lands

By C. N. Perry*

A method of earth-road maintenance by turning irrigation water upon the roadbed is in vogue in Imperial County, Calif., which could perhaps be used to advantage in other irrigated sections of the arid West. The roadbed is constructed with a center ridge or dike and with a dike on each side forming two distinct roadways. These dikes are usually made about 6 to 8 in. in height, and the center one should be 8 ft. in width, so that a wagon can travel on it should occasion require.

The irrigated section of the Imperial Valley where such roads are maintained is very level, and the only construction work necessary in most cases has been to give the roadbed a light plowing and then, with a fresno scraper, move the soil thus loosened to the line of the central and outside dikes. This done, the two roadways are leveled by dragging and are ready for irrigation. The most convenient irrigating ditch is tapped, and a stream of water from 3 to 4 in. deep is turned on one of the roadways.

By practice the roadman learns just when to turn off the water, gaging it so as to cover the entire distance without ponding the water at the lower end of the stretch. Practice in handling the road after that varies with the ideas of the roadman. Some wait until the road is very nearly dry and then drag it again; others appear to consider their work done when the water has been turned on and shut off again.

The Imperial Valley soil varies from a fairly heavy clay, a silt loam and sandy loam to a sand which when wet is practically a quicksand. The heavier soils respond to this flooding treatment, but the sand, having absolutely no binder in it, soon dries out and is as bad as ever. The soil that does respond is encountered much more often than is the sandy soil, but sandy spots occur even in the heavier soils.

There is no law against traveling the flooded side, except that which good sense dictates. The soil, when wet, is so soft and sticky that no one will willingly turn in on the wet side. However, a bunch of cattle being driven along the road is not so particular, and as a result of their wanderings a road which might be within two days of being ready again for travel is made worse than it was before the water was turned on. Just when the half of the road that has been flooded is ready for the resumption of traffic is left to the discretion of the traveling public, and each man decides for himself which side he will take. As a result a road may be cut into deep ruts before it is thoroughly dry.

The expense of maintenance by this method simply means the cost of three trips of a wooden float pulled by a four-horse team, which would probably drag a mile of road (one side only) in 1½ hr. After that it is merely a question of turning on the water and leaving a man on the job with a shovel, to see that no high places have been left, which might escape flooding. How much this should cost depends so entirely on the amount of judgment employed that I can give no figure. The flow of water along most of our roads is at the rate of about 1 mi. in 2 hr. If the irrigator planned his work, he could either attend to flooding two roads in the same locality at once or could so arrange his work that he could do something else while waiting for the water to travel to the other end. This brings in the personal equation, and I imagine the cost per mile varies widely.

The county is divided into five road districts, each with a supervisor in charge. The supervisor selects his own road foremen, and they in turn select their own workmen. The foremen and workmen may be farmers living near the road to be constructed or improved. The county engineer has nothing to do with either the first construction or subsequent maintenance of the roads. He is called in when the construction of the road necessitates a bridge or when there is some unusual feature on which his opinion is desired. Otherwise, all the details are handled by the supervisor through his road foremen. I know of no other method we could have employed which would have given us passable roads; but at the same time the roads are, and always will be, only makeshifts.

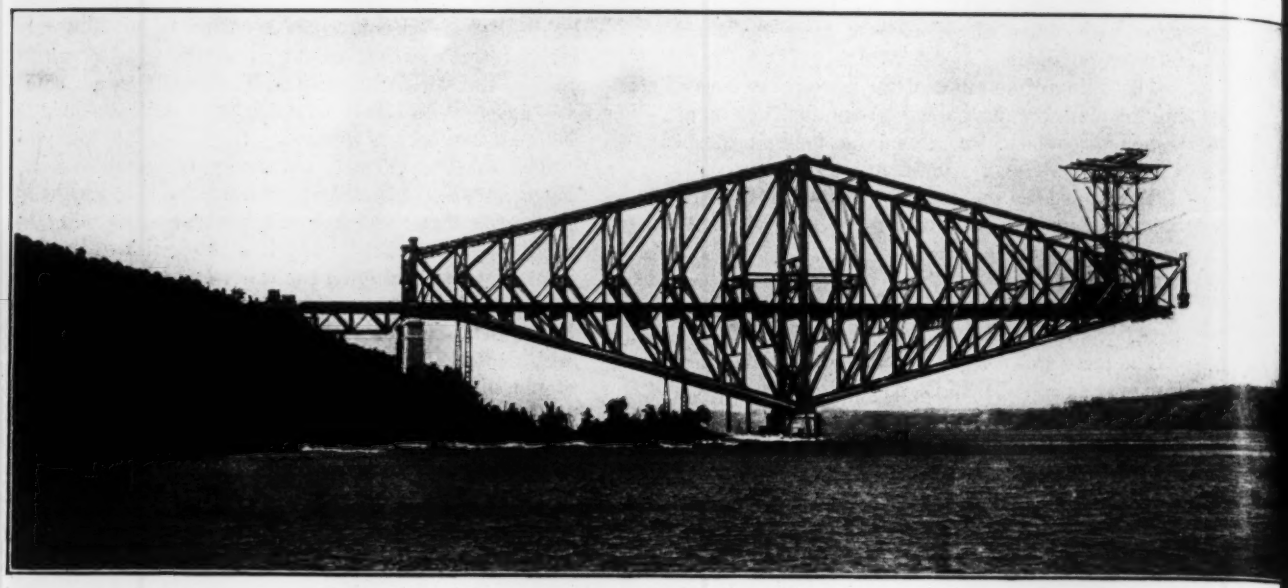
*County Surveyor, Imperial County, El Centro, Calif.

Use of Injunctions Limited in Labor Suits

A statute limiting the use of court injunctions in labor disputes is declared unconstitutional in Massachusetts. The Massachusetts Legislature in 1914 passed a law limiting the use of injunctions in labor disputes on the ground that the right to labor and to contract for labor was a personal and not a property right. The Massachusetts Supreme Court, in deciding a case where two trade unions were in litigation with each other, recently ruled that this law is unconstitutional because it deprives the lawful owner of property of equal protection under the law and thereby subjects it to confiscation. The court in its decision said:

> **The statute provides that the property rights of labor of any individual or number of individuals associated together shall not be recognized in equity as property. . . . That a man cannot resort to equity respecting his property right to work simply because he is a laboring man, and that he cannot have the benefit of an injunction, when such remedies are open freely to owners of other kinds of property needs scarcely more than a mere statement to demonstrate that such a man is not guarded in his property rights under the law to the same extent as others. It is beyond the power of the Legislature to declare that without any process at all, a well-recognized kind of property shall no longer be property. Lawful property cannot be confiscated under the disguise of a statute.**

Dry Farming and Irrigation in New Zealand are receiving increasing attention. There are large areas where the rainfall is scant and farming by the ancient method is not profitable. The soil is fertile if moisture can be secured, and it is claimed that there are many satisfactory sites for irrigation plants.



South Cantilever Arm of Quebec Bridge Completed

By A. J. Meyers*

SYNOPSIS—The south cantilever arm of the new Quebec Bridge was completed on July 28. About 13,000 tons of steel was placed in 92 working days—over a month ahead of schedule. Description of erection work and equipment.

During the season of 1915 the material of the new Quebec Bridge erected on the south shore of the St. Lawrence River consisted of the inside falsework carrying the anchor-arm floor and traveler tracks, the outside staging carrying the anchor-arm truss material and bracing, and all material of the south anchor arm complete, including the main post and the links at the top of the main post connecting the top chords of the cantilever and anchor arms. The total weight of steel erected by the one traveler on the south shore during the season of 1915 amounted to approximately 20,000 tons, including the weight of the falsework. At the close of the working period the traveler was standing over the south main pier, prepared to begin the erection of the south cantilever arm as soon as the working season for 1916 opened.

The erection of the 13,000 tons of steel in the south cantilever arm was started about Apr. 1, 1916, by which time the traveler machinery and tackle had been thoroughly overhauled. The members of the cantilever arm placed by the traveler while standing over the main pier are shown in heavy lines in Fig. 2.

Use of Flying Bridge

The first half of the flying erection bridge which was used, panel after panel, to support the bottom chords and laterals, as well as the main tension verticals, until these members were properly aligned, their splices riveted completely and the final connections to the upper truss members made, was first placed in position, connected up to its bearings on the main shoes and the front end tied back by yoking girders and links to the main post.

This erection bridge is illustrated in Fig. 5. It was made up of four plate girders of a length equal, approximately, to the longest main panel of the cantilever arms. These girders were placed in pairs under the chords of the trusses on each side of the bridge. The two girders forming a pair were spaced far enough apart to allow ample working space for the men on each side of the bottom-chord members as they were temporarily supported on the bridge. The girders of each pair were braced together by cross-girders which transferred the load of the truss members to the girders and also provided seats for the hydraulic jacks which were used for aligning and connecting these truss members. Each pair of girders had a complete bottom lateral system and a wooden floor supported along the bottom flange. This wooden floor between the girders completed a commodious working apartment for the assemblers and riveters who were working on the chords. The pairs of girders were braced together by two transverse plate girders which had a separate lateral system of their own. These transverse girders had to support the bottom-chord laterals until the end connections were made.

The erection bridge was thus a complete erection unit and was handled as such. It was supported, while in use, at the end nearest to the main pier by pins connecting to brackets which were bolted to the bottom flanges of the chord members already placed. The other end was held up by links at the center and end of the erection bridge. These links were attached to yoking girders which straddled the compression diagonals already erected overhead and in the panel to the rear.

The method of handling by the traveler cranes of the erection bridge while being moved forward into a new position is illustrated in Fig. 6. The links to the

*Chief Draftsman, Board of Engineers, Quebec Bridge, Montreal, P. Q.

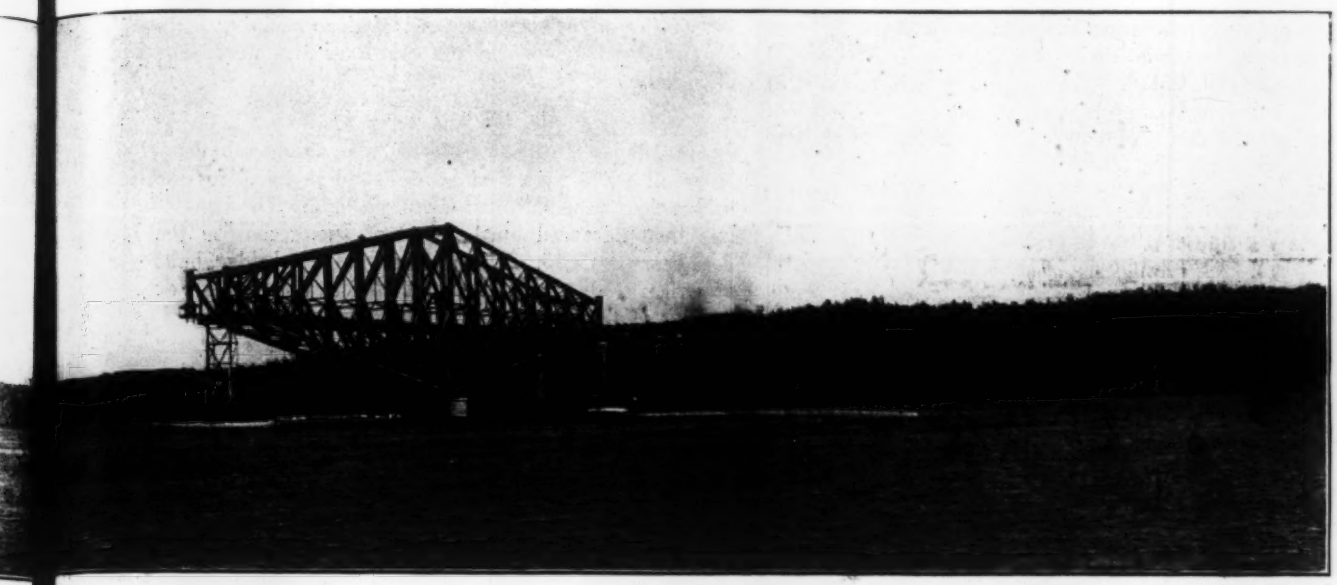


FIG. 1. THE QUEBEC BRIDGE ON JULY 31, 1916, WITH BOTH CANTILEVERS COMPLETED. ON THE SOUTH ARM, TO THE LEFT, THE ERECTION TRAVELER IS IN ITS LAST POSITION. THE NORTH ARM, TO RIGHT, ALREADY HAS IN PLACE HANGING TRUSS, FOR GUIDING THE SUSPENDED SPAN DURING ITS MOORING

forward end were first disconnected. The load of the erection bridge was then taken by the rear cranes, links L1 were disconnected, and the pins connecting the bridge to the chord brackets were removed. The bridge was then lowered and moved forward until stopped by the bottom laterals of the chord panel just completed. At this point the bridge was connected up and the load transferred to the hoisting tackle of the front cranes. The bridge was then moved forward and lifted up into its new position.

Cantilever Bottom Chords

In the first main panel CL16-CL14, as soon as the first section of the erection bridge was in position, the pair of 30-in. pins, with their 45-in. semicircular sleeves, for the cantilever arm bottom chords, and the 20-in. pins, with 30-in. sleeves, for the main compression diagonal CL16-CM14, were first placed on the shoes at CL16.

The first sections, CL16-CL15, of the cantilever-arm bottom chord were then placed on the erection bridge and carefully centered and aligned from the shoe. These members, built entirely of nickel steel, having a cross-sectional area of 1,630 sq.in., with outside dimensions of cross-section 84 in. deep by 124 in. wide, are the heaviest pieces in the cantilever arms. Each main-panel chord, made up of four vertical webs laced longitudinally in three horizontal planes, was divided into two half-panel sections, the members being fully spliced at this half-panel point in material and rivets, as well as being accurately faced to as nearly a perfect bearing as modern equipment and machinery could make possible. Each half-panel section was again divided vertically along its longitudinal center line. The member was shipped and handled in these sections, the heaviest of the sections weighing 160,000 lb. Each section was handled by means of specially designed and tested hitches bolted to the top flanges, two sets of hitches to each section. The sections were lifted from the cars in pairs, at the same time, one section for the east truss and the corresponding section for the west truss, all four of the 55-ton hoists of the two traveling cranes at the top of the traveler being used, one hoist of each crane to a section. The sections after leaving the cars were "fleeted" apart until

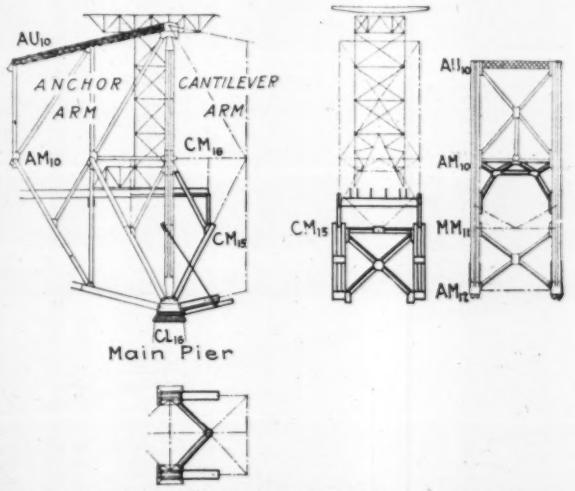


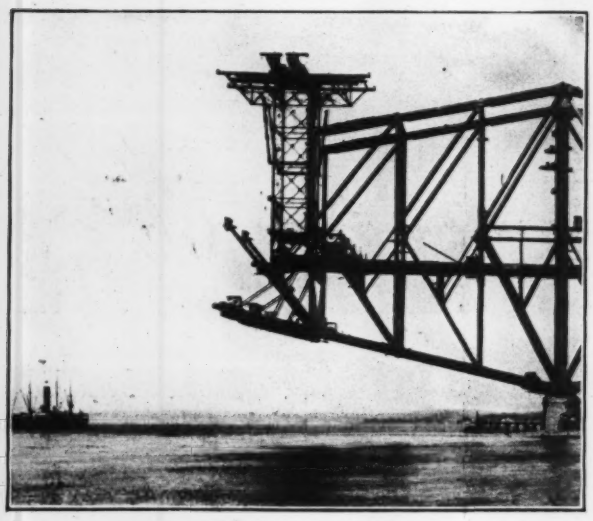
FIG. 2. CANTILEVER MEMBERS PLACED BY TRAVELER OVER MAIN PIER

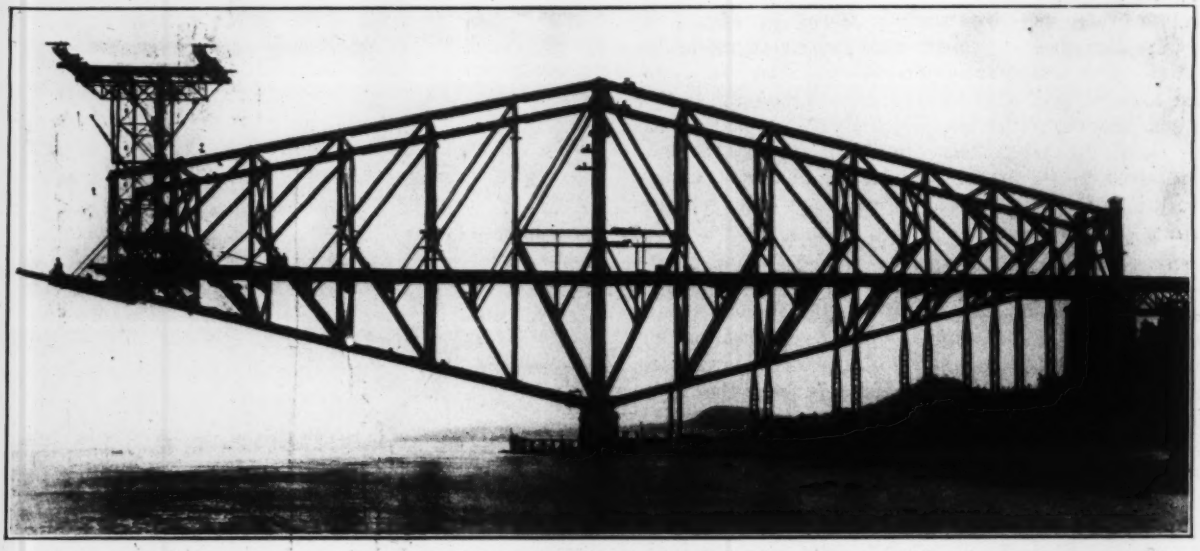
they hung vertically over their positions on the erection bridge, when they were lowered into place.

The erection of the half-panel of the bottom chords was followed by the placing of a half-panel of bottom laterals, panel CL16-CL15, from the shoes to the middle intersection plate. The middle intersection plate and the lateral members themselves rested on the transverse girders of the erection bridge. The bottom lateral system is a double intersection system with a strut at each main-panel point. Each of the diagonals in a panel of the system is designed to take compression as well as tension. The lateral members are of nickel steel, the largest cross-sectional area being 98.7 sq.in., made up of eight 8x8x$\frac{13}{16}$-in. angles, built into a box section with a depth equal to that of the bottom chord and latticed in the horizontal and vertical planes.

The small subtension diagonals, CM16-CM15, were next hung from the main post by driving the pin at the upper end, CM16. These members were followed by the placing and careful centering on the shoe pins of the lower section, CL16-CM15, of the main compression diagonals.

As shown in Fig. 7, the upper ends of the sections were tied back and held in position temporarily by tackle





FIGS. 3 AND 4. PROGRESS OF ERECTION OF SOUTH CANTILEVER

Fig. 3 (Above)—South cantilever on June 15, 1916. Fig. 4—The south cantilever on July 11, 1916. Erecting three panels in less than three weeks is a fair sample of the speed of progress on the work. In Fig. 3 the bottom chords, temporarily supported by the erection bridge, are tied back by links and yoking girders to the compression diagonals

to the main post. As soon as the two halves of the lower sections were placed, the pins connecting the subtension diagonal, CM16-CM15, to the main compression diagonal at CM15, were driven, and the sway bracing for these lower sections was placed in position. These compression diagonals are built members with an arrangement of cross-section similar to that of the bottom chord, but of much smaller area. They are spliced, shipped and handled in a manner similar to the bottom-chord members. The diagonals in the panel next to the main pier, where the weight of the member itself has practically no influence on the remainder of the bridge, were made of carbon steel. All of the remaining main compression diagonals in the cantilever arm were built of nickel steel.

Bridge Floor-Beams

The subposts CM15-CF15, and the single-web floor-beams at CF15 were next erected, and the steel for the bridge floor from CF16 to CF15 was laid. The traveler was then advanced until the front legs rested on the floor-beam at CF15. The floor-beams of the bridge, built of carbon steel, are 88 ft. c. to c. of pins, and 10 ft. back to back of flange angles, the heaviest weighing approximately 120,000 lb. In the majority of cases for the cantilever arm they had additional material in the web and flange to take care of the shears and moments from the dead weight of the traveler and the lifted loads.

To lift these floor-beams from the cars and place them in their position in the bridge necessitated the design of a special lifting connection shown in Fig. 8. This lifting connection had two sets of cast vanadium-steel hooks which engaged the top flanges of the floor-beams. These hooks were pin-connected to hanger plates that were in turn riveted to a crosshead composed of two 10-in. 25-lb. channels. A specially designed swivel pin, with an eye at the upper end and threaded at the lower end to engage a cast-steel bearing nut, was used to transfer the load from the hoisting cables to the channel crosshead. A short cast-steel guide pin was bolted to the top of the floor-beams and served the purpose of insuring that the floor-beam would rotate about a vertical axis. The floor-beams were lifted from the cars by the two hoists of the front traveler crane, carried out until they cleared the steelwork of the traveler, then rotated through an angle of 90°, and lowered into position.

At each of these subpanel points, temporary bracing was put in from the floor-beam to the subpanel point, to transfer the wind load on the traveler to the bracing planes of the trusses.

The traveler, standing with its front legs resting on floor-beam CF15 (see Fig. 9), first erected the completing section of the erection bridge. The bottom-chord

half-panel sections CL15-CL14 were then placed on the erection bridge, jacked into line, and the splice at CL15 made. Throughout the work all splices and riveted connections in the truss members were practically completely riveted panel by panel as the traveler advanced.

Erection of Main Diagonals

The upper sections, CM15-CM14, of the main compression diagonals, were next erected and the splices at CM15 riveted up, the CM14 end of the member being tied back by tackle to the main posts, as illustrated in Fig. 7. The erection of the sway bracing below the bridge floor for the upper sections of these diagonals, the upper portions, CF15-N15, of the subposts and the subchord member CM16-CM14, followed immediately, eight gusset plates are cut so that each and every gusset engages the pins of all the other main members connecting at the joint.

The main tension diagonals, CU16-CM14, are 150 ft. 6⅛ in. c. to c. of end connecting pins. They are built up of four webs, the webs being connected and riveted together in pairs by means of lattice bars and tie-plates. The pairs are then connected by means of spacer tie-plates. Each pair of webs was shipped to the bridge site in three sections, making up the total length of the completed member.

Before erection, these sections were assembled on the floor of the bridge between the traveler and the bridge trusses, and their field splices completely riveted up. Each pair of webs was then hoisted into position sep-

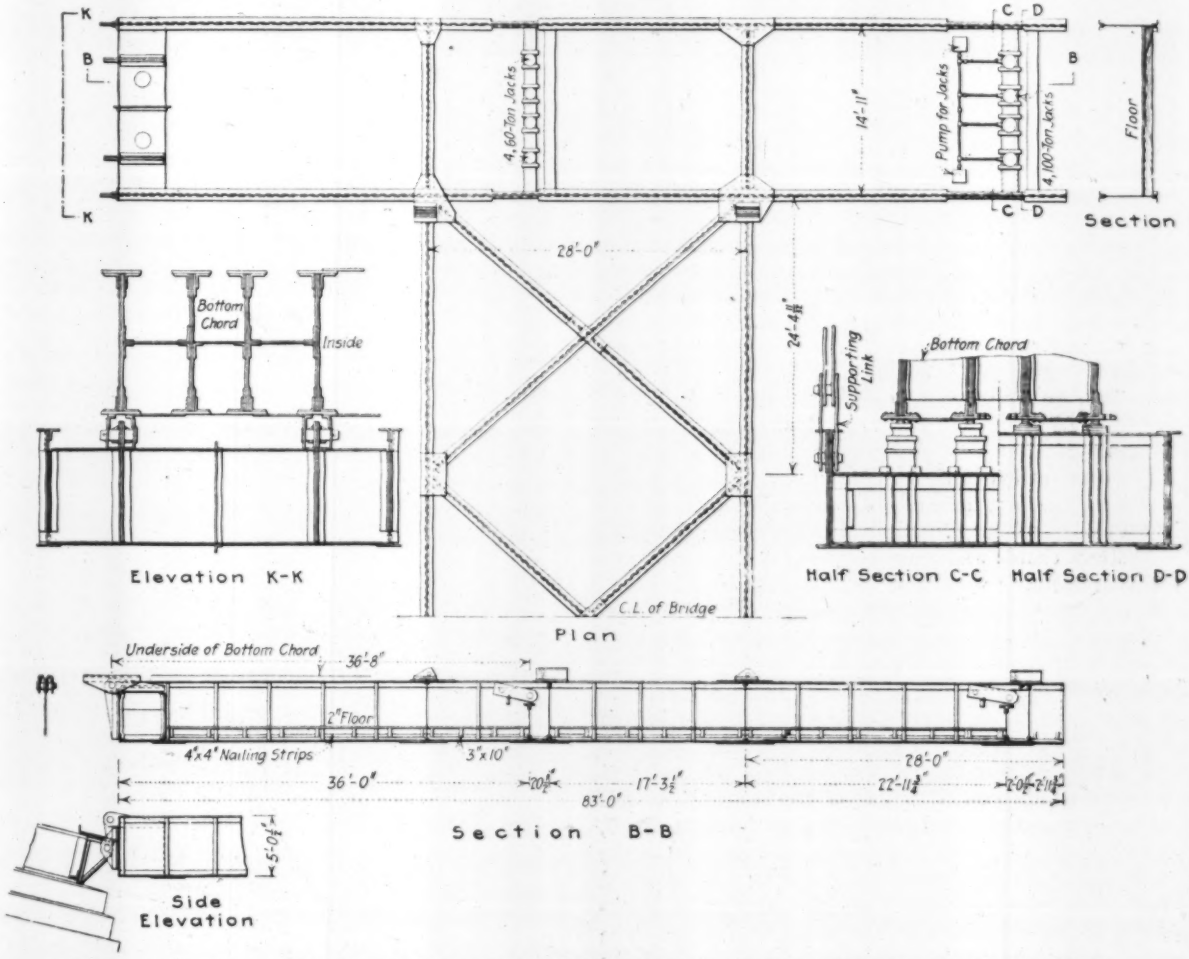


FIG. 5. ERECTION BRIDGE FOR QUEBEC BOTTOM CHORDS, LATERALS AND TENSION VERTICALS

the pins at CM16 and CM14 connecting the subchord at these points being driven.

The main-panel point CM14 is typical of all the main-panel middle points or "K" joints of the cantilever arm, except that it has an extra connection for the subchord member CM16-CM14, which appears only in the first main panel of the cantilever arm. Generally there are four main truss members and one subtension diagonal connecting at these joints, all of them being pin-connected with the exception of the main compression diagonals. The main compression diagonals have the eight large main gussets riveted into their ends. These arately by the traveler. The inner pair was first placed and the pins at CU16 and CM14 driven. Any adjustment necessary to center the pin holes was made by means of tackle leading from the panel point CM14 to the main post. Immediately after placing the inner section, the outer section of the member was erected and its pins driven. The pin holes at the lower end of the member were slotted ¼ in. on the side remote from the bearing surface in order to facilitate the driving of the pins. The main tension diagonals in the first main panel of the cantilever arm are of carbon steel; in all the other panels they are of nickel steel. The pins

throughout the bridge for each main-member connection are in half lengths, each half engaging two webs of the member and two gussets of the connection. This method of pin connection enabled the pins to be driven in all cases with remarkable ease.

Tension Verticals and Top Chords

The splice of the bottom chord at CL15 being completely riveted, the inside halves of the tension verticals, CM14-CL14, were next erected and the pins at CL14 driven. The bottom chords were then jacked up from the erection bridge until the pin holes at CM14 were in true line. The pins were then driven. The operation was then repeated with the inner halves of the tension verticals. These tension verticals are similar in built-up construction to the main tension diagonals previously described, and are shipped and handled in a similar manner. The upper pin holes were also slotted to allow the last driven pins to be easily entered.

The half-panel of bottom laterals, CL15-CL14, together with the bottom lateral strut at CL14, was next placed and the sway bracing from the floor-beam at CF14 to the bottom-chord panel point CL14 for the tension vertical CL14-CM14, was erected. The erection of the floor-beam at CF14 and the laying of the track floor from CF15 to CF14 followed immediately. The sway bracing for the tension verticals throughout the cantilever and anchor arms transfers a main-panel load of wind shear, due to wind on the floor and train, from the plane of the floor bracing to the plane of the bottom lateral bracing; also the cross-wind reaction on the front of the traveler during erection travels to the bottom laterals by the same path.

The compression verticals, CM14-CU14, which were the next truss members to be placed into position, were spliced transversely and longitudinally in a manner similar to the bottom chords and main compression diagonals, and the same methods were used for shipping, handling and hoisting into position in the bridge. All these compression verticals in the cantilever and anchor arms were of similar construction. They were built up of four plate-girder webs, spaced the same distance center to center of webs as the compression diagonals and bottom chords. They were similarly latticed in three longitudinal planes, and rested on pins in half pin holes at the main middle or "K" joints of the trusses. At this joint they were temporarily supported, as shown in Fig. 7, during erection by means of tension anchor bolts on the one side of the connection. These anchor bolts engaged brackets on the compression verticals and reaction brackets on the gusset plates of the main "K" joint. The anchor bolts were thrown into tension by means of the tackle which, as shown in Fig. 7, attached to the upper end of the member, and by means of which the member was tied back to and supported by the truss material already erected.

The erection of the truss material for the first main panel, C16-C15, was completed by the placing of the top chord eye-bars, CU16-CU14, with their supporting trusses (see Fig. 9), and driving the eight pins at CU16, connecting the eye-bars to the link at the top of the main post.

Each main-panel top chord in the cantilever and anchor arms is composed of two lines of eye-bars, spaced 3 ft. 6 in. c. to c. vertically, the one line above the other.

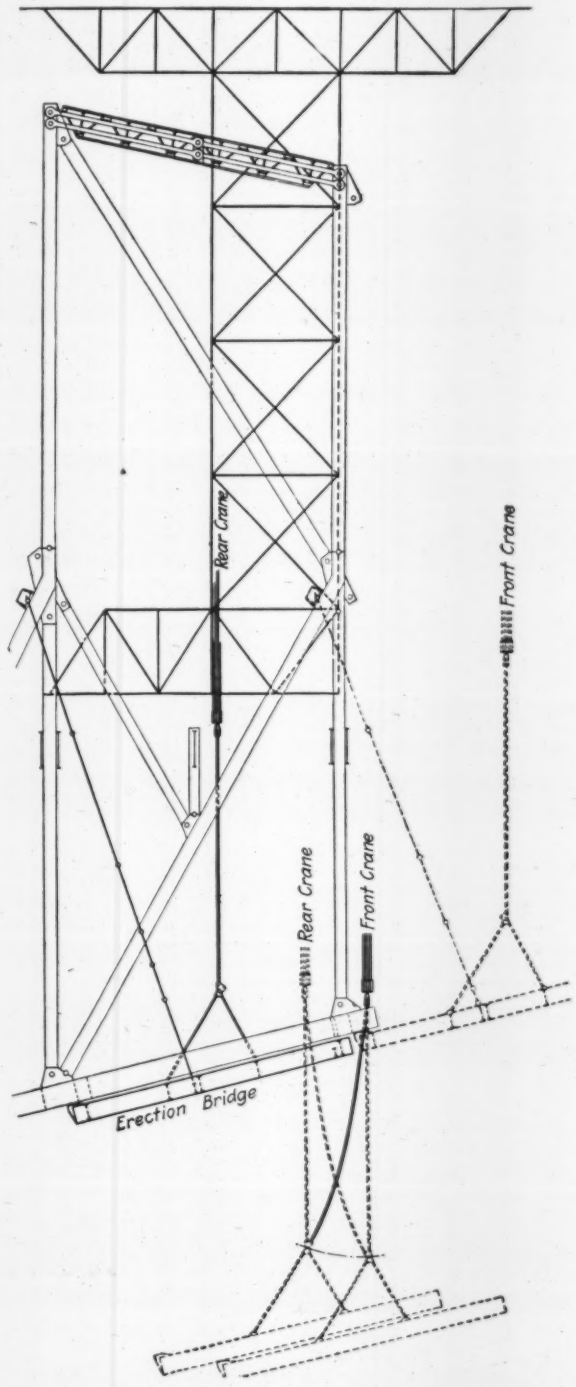


FIG. 6. TRAVELER CRANES HANDLING ERECTION BRIDGE

Each line of eye-bars in all panels over 50 ft. in length is made up of two lengths of eye-bars per panel, pin-connected to each other at the middle point of each panel, where the weight of the pins and one-half the weight of the eye-bars is taken by supporting trusses. Each supporting truss for one panel of eye-bars is made up of four single-intersection Warren trusses connected together in pairs by cover plates, tie-plates and lattice bars. The pairs of trusses are symmetrically spaced about the longitudinal center line of the chord, but are not connected. The eye-bars were assembled with the supporting trusses

in the storage yard and the middle pins put in place. They were then taken out on the bridge and hoisted into position, one-half the bars in each panel being placed at one time.

As soon as the eye-bars and supporting trusses were erected, the adjusting erection links for the top chords, illustrated in Fig. 10, were placed in position. These links were made up of a series of plates pin-connected together at the end. The plates were made of such lengths that the same links could be used panel after panel by removing or inserting extra lengths of plate to suit the varying lengths of bridge main panels. Small adjustments were obtained by means of one 100-ton jack in each link reacting against sliding cross-girder heads connecting to the plates at each end of the jack. The links, at the ends, engaged brackets which were in turn connected to the main compression vertical posts. The top-chord eye-bars had the pin holes at each end slotted ¼ in. on the side remote from the bearing surface, and these adjusting links were used to draw the top-chord main-panel points together so that the top-chord pins could be easily driven in the elongated pin holes of the eye-bars. These top-chord links also took care of any erection stress in the top-chord panel until the eye-bar pins at each end of the panel were driven. The links were placed in pairs over each chord and were put in position and connected up as soon as the panel of eye-bars with the supporting trusses was placed. They remained in this position until the eye-bars and supporting trusses in the following panel were erected. The pins at the shore end of this latter panel were then driven and the links moved forward into the next panel.

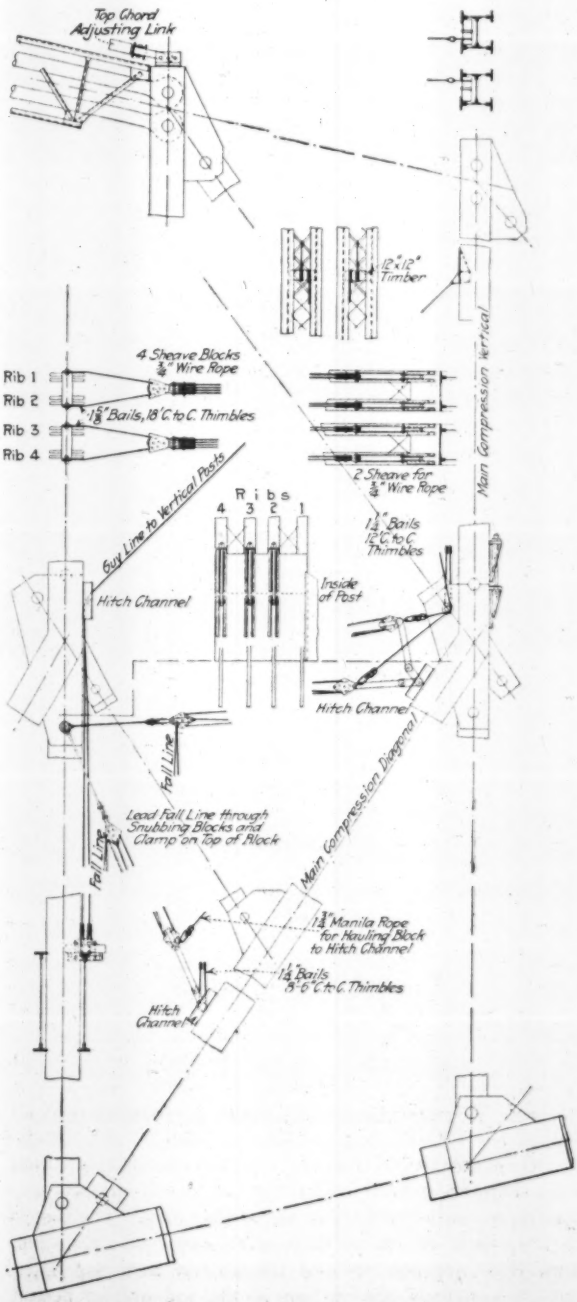

Top Chord Adjusting Link
12"x12" Timber
Main Compression Vertical
4 Sheave Blocks ¾" Wire Rope
Rib 1
Rib 2
Rib 3
Rib 4
1⅛" Bails, 18' C. to C. Thimbles
2 Sheave for ¾" Wire Rope
Ribs
4 3 2 1
1¼" Bails 12' C. to C. Thimbles
Guy Line to Vertical Posts
Hitch Channel
Inside of Post
Hitch Channel
Fall Line
Main Compression Diagonal
Lead Fall Line through Snubbing Blocks and Clamp on Top of Block
Fall Line
1¼" Manila Rope for Hauling Block to Hitch Channel
1¼" Bails 5'-6" C. to C. Thimbles
Hitch Channel

FIG. 7. ERECTION OF DIAGONALS

All the material in the panel C16-C14 was now completely erected except the sway bracing for the vertical post CU14-CM14 and that for the upper half of the main compression diagonals, CM14-CL16, which could not be placed until the traveler had moved forward out of the way.

Completing Sway Bracing

The traveler was next advanced until the front legs rested at panel point CF14. The erection bridge was moved forward into position to take the chord members of the following panel and the erection of this next panel and the panels following was proceeded with in a manner practically identical with that followed for the first main panel, as previously described. When the traveler was moved forward to panel point CF13, the sway bracing for the vertical compression post, CU14-CM14, was placed in position; and when the traveler was moved forward to panel point CF12 the portal bracing of the main compression diagonal, CM14-CM15, was erected by the rear booms of the traveler.

The placing of this bracing finished the erection of the complete system of sway bracing for the compression web members in the first main panel. This system of sway bracing is a double-intersection system designed to take both tension and compression in each member, and follows the line of members from CU14 to CM14 to CL16. It takes the panel wind shear from the top-chord and web members of the trusses, carrying it to the plane of the bottom lateral system. Throughout the cantilever and anchor arms there is no top-chord lateral bracing, but in each main panel there is a system of web bracing similar to that just described.

Progress Dates

As already stated, the erection of the first main panel of the south cantilever arm C16-C14 was started April 1, 1916. On Friday, Apr. 28, the traveler was moved forward to panel point CF14, the first main panel being practically completed. The number of days, 10 hr. to each day, actually worked was 22½, only 2½ days having been lost on account of high winds and rainy weather. The amount of steel erected during this time was in the neighborhood of 3,100 tons and included the placing of the largest, longest and heaviest members of the cantilever arm. An average of 200 men for each working day were employed on the work, including from six to eight gangs of riveters.

The material in the second main panel was completely erected by May 26. The steel in this panel weighed approximately 2,650 tons, and was erected in 18 working days. The 1,960 tons in the third main panel was placed by June 12, in 13 working days. The methods employed in the erection of the material in these two panels were similar to those described before, with nothing especially worthy of note except perhaps the placing of the traction truss in the third main panel.

This traction truss is placed in the plane of the sway bracing for the main compression diagonals below the floor line and forms part of the sway-bracing system for this panel. The truss is connected up to the track girders at the floor line and takes care of the traction between the expansion joints at the main post and at panel point

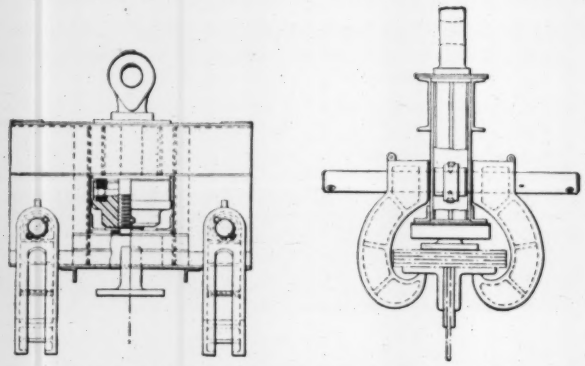


FIG. 8. LIFTING CONNECTION FOR QUEBEC BRIDGE FLOOR-BEAMS

CF7. This truss is a double-intersection latticed girder designed throughout to take both tension and compression in each member. It is 22 ft. deep and 88 ft. long, and weighed in the assembled condition 52,000 lb. It was riveted up completely on the floor of the bridge in front of the traveler and then lifted and placed in position in one piece, using the two main hoists of the front crane of the traveler and the two forward derrick booms.

As the traveler progressed toward the end of the cantilever arm, the members handled were lighter and the field splices fewer and smaller. The rate of progress was therefore greatly increased. By July 10 the traveler had completed the erection of six main panels of the bridge and was standing at panel point 4. The fourth, fifth and sixth main panels were erected in 22 working days, the total weight of steel in these panels amounting to approximately 3,600 tons.

The traveler was moved to its last position at the end of the seventh main panel on July 20. The weight of the steel in the last two main panels amounted to about 1,280 tons. This was placed in 18 working days.

The south cantilever arm was therefore completely erected between Apr. 1 and July 28, 1916. The total weight of steel placed was about 13,000 tons. This material was erected in 92 working days, about 27 days being lost from high winds, inclement weather, Sundays and legal holidays. The south cantilever arm was completed over a month ahead of schedule time and in over 25% less working time than for the north arm.

The pin holes in the eye-bars used in the anchorage chain and the top chord of the anchor arms had each been slotted ½ in., making a total of 2 in. adjustment for each top-chord main panel. The upper pin holes of the main tension diagonals of the anchor arm had also been slotted 2 in. The anchor arms were cambered and the elevations of the tops of the falsework columns carrying the anchor-arm trusses were made of such a height as to allow the top-chord main-panel points to be brought 1 in. closer together than the manufactured length of the eye-bars demanded; slotting the holes enabled this to be done without any difficulty. The purpose of this camber was to avoid as far as possible any trouble that might arise in driving the huge pins connecting the main truss members.

Anchor-Arm Movement

As the erection of the cantilever arms proceeded, the slack in the anchor-arm top chords and main tension diagonals was taken up gradually and almost imperceptibly panel after panel. The first effect of cantilevering, in raising the bottom-chord panel points of the anchor arm, was observed after bottom chord CL11-CL10 had been placed. At this time the middle panel points AL6-8 and 10 of the anchor-arm bottom chord had lifted about $\frac{3}{16}$ of an inch. As the traveler moved forward panel after panel on the cantilever arm, these bottom-chord panel points of the anchor arm were observed to lift in amounts varying from ¼ to ⅜ in. for each additional panel of cantilever-arm material erected. When the traveler was moved out to the end of the sixth main panel of the cantilever arm, the slack in the chain of anchorage bars at the anchor piers was observed to be gradually taken up. This showed that the erection of the cantilever arm had reached a point where the weight of the cantilever arm plus the weight of the traveler

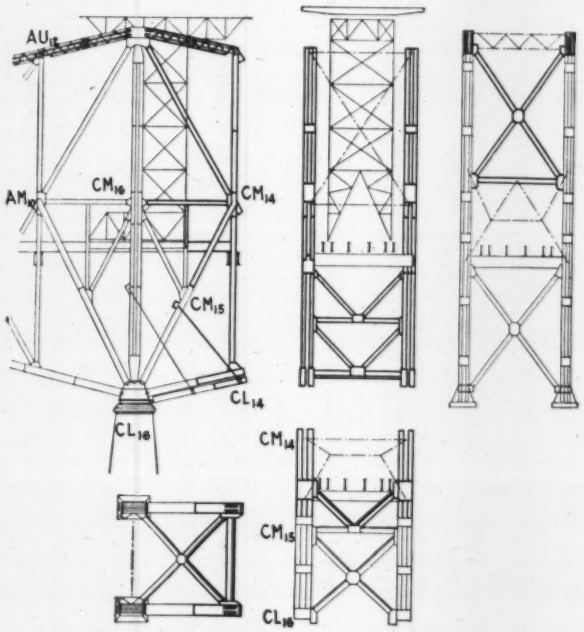


FIG. 9. TRAVELER MOVED UPON CANTILEVER

slightly overbalanced the weight of the anchor arm. Jacks were therefore placed under the falsework columns supporting panel point No. 2 of the anchor arm. The toggles in the chain of anchor bars were eased off; the jacks were then pumped up and the anchor arm was lifted until the chain of anchor bars at the anchor pier became taut. Steel shims were then driven in under the false-

work columns at panel point No. 2, and the erection of the remaining panels of the cantilever arm proceeded.

The work of erection of the large compression members was greatly facilitated by the high degree of accuracy that had been required in the shop work. All members which were spliced together in the field were temporarily assembled in the shop and their splices reamed and matchmarked to insure a perfect fit in the field. All holes for field connections, other than field splices in main members, were drilled to a steel templet $\frac{3}{16}$ in. thick, with case-hardened thimbles $1\frac{5}{16}$ in. deep. Where it was necessary to take the pieces apart for shipping and handling, the respective pieces reamed together were

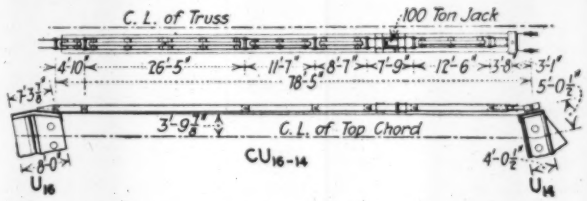


FIG. 10. ERECTION LINKS FOR TOP CHORDS

matchmarked so that they could be reassembled in the same relative position in the final setting up in the field. In the field-splicing of main members, the two portions of the members were accurately faced, assembled in the shop to exact length, and held firmly in position with rods and turnbuckles. The splice material was then placed in position and the holes finally drilled through the main and splice material.

The workmanship and finish required throughout in the shop was the best that the most suitable modern machinery and skilled labor could give. All finished measurements were made with standardized tapes lying flat and supported at frequent intervals, firmly held at one end, and under a tension of 10 lb. The policy of assembling, reaming and matchmarking all members with field splices has been found to give the best of satisfaction, even though it involved considerable extra expense in the shop. The connections in the field were made with so little trouble and loss of time that it is considered that the extra shop cost was fully warranted.

Assembling the Suspended Span

With the completion of the south cantilever arm the bridge is in readiness for the floating in and hoisting into place of the suspended span. This span is 640 ft. long, 88 ft. wide and weighs in the floating-in condition approximately 5,000 tons. The greater part of the floor steel will be left off during the floating-in operation and will be placed by means of derrick cars after the span is coupled up to the ends of the cantilever arms.

The suspended span has been erected in the shallow waters of Victoria Cove, about three miles below the bridge site. The work of erection proceeded simultaneously with that of the south cantilever arm. Foundations for the falsework bents supporting the trusses and the approach track were prepared at the periods of low tide during the season of 1915. This work was rather difficult and could not be carried on with any great speed as the time available was only from two to four hours each day. During erection, the suspended span was supported on staging placed under each panel point. The traveler which erected the north-shore cantilever and anchor arms was erected on bents immediately adjacent to the staging of the span, with the top trusses and traveling cranes left off. All the steel was handled by means of four 70-ft. 30-ton booms, placed one at each of the four corners of the traveler. After the span had been completely erected on the staging, the intermediate staging supports were removed and the span swung on the end supports.

Floating In the Span

In this condition six scows, 32 ft. wide and 160 ft. long, with 11 ft. 7 in. draft, will be floated in and placed under panel points at each end of the span. The valves in the bottom of the scows will be opened and the scows sunk until they rest on their foundation supports. The cross-girders and bracing which transfer the load of the span to the scows will then be placed. To raise the span from the end supports preparatory to floating out, the scows will be drained at low tide and the bottom valves closed; then as the tide rises the span will be lifted gradually and will be in readiness to proceed on its journey to the bridge site, if the weather and tide conditions are considered favorable. While the span is being moved to the bridge site, it will be kept under control by means of tugs of sufficient power capacity to overcome all anticipated resistances due to wind or current. Arriving at the bridge site, the span will be anchored to the ends of hanging trusses, coupled up to hanger slabs

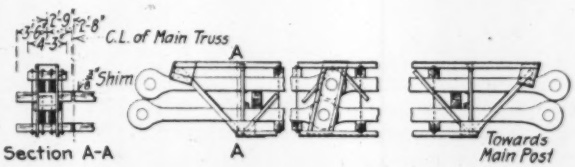


FIG. 11. PANEL OF TOP-CHORD EYE-BARS AND SUPPORTING TRUSS

provided at each of the four corners of the cantilever arms, and raised into its final position by means of movable jacking girders and eight 1,000-ton hydraulic jacks, two at each corner.

The work is being carried out under the supervision of the Board of Engineers, Quebec Bridge, consisting of C. N. Monsarrat (Chairman and Chief Engineer), Ralph Modjeski and H. P. Borden. The St. Lawrence Bridge Company is the contractor for the superstructure, George H. Duggan, being Chief Engineer, George F. Porter, Engineer of Construction, W. B. Fortune, Superintendent, and S. P. Mitchell, Consulting Engineer of Erection.

Competition of Government Engineers with engineers in private practice is agitating the engineering profession in New Zealand. At the annual meeting of the New Zealand Society of Civil Engineers a discussion on this subject is reported as follows in the "Commonwealth Engineer":

Mr. H. F. Toogood stated that the Lake Takapuna Board of Control had requisitioned the government for the services of an engineer to report on the water system. The writer expressed the opinion that the society should protest against local bodies "sponging" on the government for engineers' services. Mr. J. A. Menzies said there were county councils in Otago that employed engineers at £180 per annum and got the government to supply plans which, if the county council employed fully qualified men, would mean the employment of engineers at £300 or £400 per annum. The following resolution was carried: "That the attention of the council should be drawn to the fact that a local body has requested the government to grant the services of one of its engineers to report on a matter of engineering, and that the council be requested to take the matter into consideration with a view to taking such steps as may be necessary for the protection of engineers in private practice."

Surveying Dam Sites in the Grand Canyon

What promises to be one of the most interesting hydroelectric developments in this country has been initiated by the Grand Cañon Power Development Co., the moving spirit of which is James B. Girand, City Engineer of Phoenix, Ariz., and former Territorial Engineer of Arizona. Few engineers are more familiar with the power possibilities of the Colorado River. After many explorations and reconnoissance surveys, he obtained in 1915 from the Secretaries of the Interior and of Agriculture rights on six power sites in the Grand Cañon.

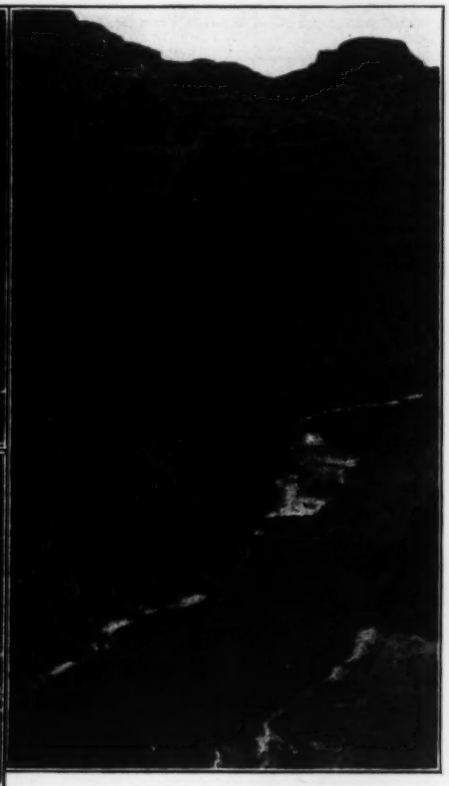
One of these sites, which has been fully explored and surveyed during the present year, is shown in the accompanying views. It is in a little-known but easily accessible part of the Grand Cañon. This is at the foot of Peach Springs wash, at the mouth of Diamond Creek. It is reached by a wagon road from Peach Springs, 21 mi. distant on the main line of the Atchison, Topeka & Santa Fe Ry., being, it is said, the only place in the Grand Cañon where a wagon may be driven to the water's edge.

The survey camp shown in one of the views was established early in the present year. Extensive topographic surveys and soundings of the river have been made. The difficulties of such surveys are more easily imagined by those familiar with Grand Cañon topography, or from the photographs, than can be described.

The sides of the cañon rise abruptly 600 or 800 ft. above the river. Then there is a shelf more or less regular, back of which are a bluff and another shelf and then another bluff. The lowest stratum is granite, and in places many great boulders of granite line the river's edge, so that there is no scarcity of construction material. There is practically no soil, and all survey stations have to be drilled into the rock.

All topography was taken by stadia, and all survey stations were established by triangulation and stadia. A base line about 200 ft. long was laid out at the mouth of the creek along the river bank, and from the ends of this base line the survey was extended for several thousand feet on either side of the river.

VIEW OF THE GRAND CAŠON OF THE COLORADO; SURVEYORS' CAMP AT DIAMOND CREEK



DAM SITE AT DIAMOND CREEK IN THE GRAND CAŠON OF THE COLORADO

The Colorado River has a mean monthly discharge of about 30,000 sec.-ft. The total fall embraced in the six proposed dam sites is approximately 600 ft. The original project was to build six 100-ft. dams of the overflow type and to utilize the entire fall of the river. The average fall here is about 5.9 ft. per mi. The site shown, however, is such an excellent one that plans have been prepared for a 250-ft. dam at this place.

The bedrock of the river bottom is here only 25 ft. below mean low water. There is no silt on the river bottom, but there is plenty in the water itself, which has literally the color of sand. On account of the grade and the section, the cañon of course provides little storage

capacity; but it is intended to develop only the normal flow of the river, so that silting up of the reservoirs behind the dams would be no detriment.

Construction work could be carried on at seasons of low water when the flow of the river could be diverted through a tunnel, to be later used for the power-plant intake. The present wagon road may be made passable for motor trucks, or it is possible a railway will be built to the dam site. Diamond Creek furnishes a water-supply for camp and construction purposes.

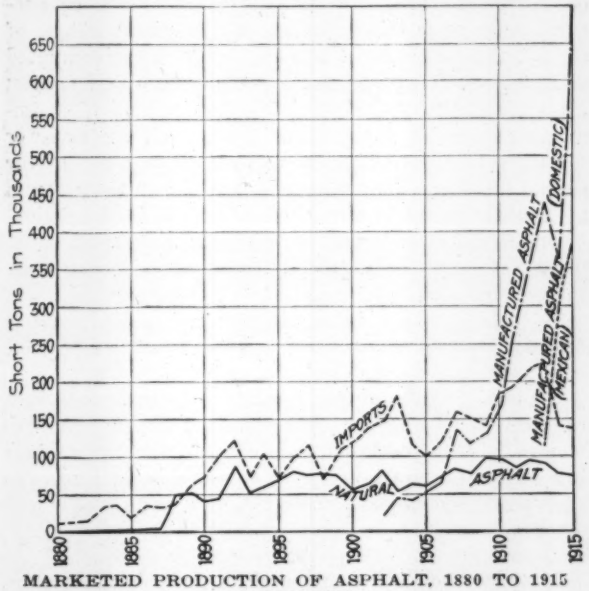
The Peach Springs dam site is about 80 mi., in a straight line, below Grand Cañon, where the Santa Fe Ry.'s Hotel El Tovar is located. At the river's edge the topography is much the same as it is at the foot of the famous Bright Angel Trail.

Increasing Use of Asphalt

The tremendous increase in the production of asphalt from the time it began to be used to any great extent for street paving to the end of the year 1915 is shown in the recent Bulletin II: 13 of the United States Geological Survey. The total production in 1882 was 3,000 tons, valued at $10,500 ($3.50 a ton), and in 1915 the amount was 1,266,824 short tons, valued at $9,652,866 ($7.63 a ton). The production has thus increased several hundred-fold, and the value per ton has more than doubled.

The accompanying diagram shows the production differentiated into natural asphalt, imported asphalt, that manufactured from domestic petroleum and that manufactured from Mexican petroleum. The enormous increase in the manufactured asphalts is apparent, but this includes (in 1915) nearly half a million tons of asphaltic road oil.

The number of plants supplying manufactured asphalt in the United States in 1915 was 39, of which 28 utilized exclusively domestic petroleums and 9 exclusively



MARKETED PRODUCTION OF ASPHALT, 1880 TO 1915 INCLUSIVE

Mexican petroleums, while 2 utilized petroleums from both sources. The manufactured asphalts did not become a factor until 1902.

The European War has adversely affected the asphalt production of Trinidad and Venezuela, because European demand for Trinidad asphalt formerly averaged about the same as that of the United States; but during 1915 the European demand fell off 57,000 long tons. This decrease was, however, largely made up by an increased demand in the United States.

There are still large undeveloped deposits of asphalt in Cuba, and during the last year the bituminous sands of northern Alberta, in Canada, have been used successfully for pavements.

Recommended Pavements for Boston Streets

A committee of engineers appointed by the Mayor of Boston, Mass, to make recommendations as to the policy to be followed in repaving the city's streets reported on June 15. The report consists of two typewritten pages. The major part of it follows:

The types of surfacing recommended for the various classes of streets are:

Class 1. Heavy traffic streets—Granite blocks laid on portland-cement concrete base not less than 6 in. in thickness, the joints to be filled with portland cement grout; in the case of excessive grades, pitch to be substituted for grout in the upper inch or so of the joints in order to provide better foothold for horses.

Class 2. Main arteries—The same type of pavement as Class 1, with a few exceptions where the surroundings require a smoother and less noisy surface, such as wood blocks or the best grades of bituminous pavements.

Class 3. Retail shopping and office building districts—Treated wood-block pavements, the best grades of bituminous pavements on a portland-cement concrete base. At the present time the only wood recommended for wood-block pavements is long-leaf yellow pine.

Class 4. Residential districts in the city proper—Treated wood-block pavements, the best grade of bituminous pavements or portland-cement concrete pavements; the choice to be determined by the intensity and character of the traffic.

Class 5. Suburb and residential districts—Cheaper types of bituminous pavements, using old macadam surfaces for the base where suitable, or portland-cement concrete pavements.

Class 6. Park roads carrying only pleasure traffic—Bituminous pavements using old macadam for the base where suitable, or portland-cement concrete pavements.

The committee deemed it inadvisable and unnecessary to prepare new specifications for the pavements recommended in view of the fact that most excellent specifications have been carefully prepared after thorough discussions by experts, and adopted by organizations of high standing. It was recommended that paving work done by the city and the provisions and requirements of any guarantees relating to such work should conform substantially to specifications adopted by the American Society of Municipal Improvements for granite block, wood block and bituminous pavements; for portland-cement concrete surfaces the work should conform substantially to the standard specifications of the American Concrete Institute.

The committee were: James H. Sullivan, division engineer, Public Works Department; H. J. Hughes, professor of civil engineering at Harvard University; G. C. Emerson, consulting engineer, Boston Finance Commission; John R. Rablin, chief engineer of the Metropolitan Park Commission, and A. W. Dean, chief engineer of the Massachusetts Highway Commission.

The Changes in Incandescent Electric Lamps are indicated in a report presented at the recent annual meeting of the National Electric Light Association, at Chicago. The total number of lamps sold for domestic purposes in 1915 was about 110,000,000 of which 78.89% were tungsten-filament lamps, with "Gem" lamps (metallized-carbon filament) 15.68% and carbon lamps only 5.43%. The tantalum lamp has disappeared during the past two years.

Engineering Literature

Retaining Walls and Bins

EARTH PRESSURE, RETAINING WALLS AND BINS—By William Cain, M. Am. Soc. C. E., Professor of Mathematics, University of North Carolina. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 287; 99 illustrations. $2.50 net.

REVIEWED BY EDWARD GODFREY*

The author first takes up the theories of earth pressures, treating the fill behind a wall as a mass with a small cohesion. He next develops the theory of earth pressure, considering the earth as a noncohesive granular mass. Coming to retaining walls, he emphasizes the features of design that must be considered for stability and safety. Returning to the theory of earth pressures, the bracing of trench lagging and the pressures on tunnels are discussed. The sixth chapter takes up grain and coal bins and finds their theoretical stresses and pressures. An appendix of about 35 pages is chiefly a theoretic treatment of wedge-shaped reinforced-concrete beams. A second appendix, of four pages, is devoted to experiments on model retaining walls. The book contains useful tabular data, such as the coefficients of friction and angles of slope of various substances.

The author again proves himself a master of the theories of engineering mechanics. Some sound principles of reinforced-concrete design are enunciated, such as the need of easy curves (or the error of sharp bends) in rods under high stress (25 diameters of the rod for the radius of curve), the need of ample area in bearing for anchoring pieces, the need of proper anchorage for tension rods, as in the counterfort of a retaining wall. The latter point is nullified, however, by the sample design; for while the text on page 163 apologizes for the lack of proper anchorage if simple rods are embedded 10 in. in a wall, the figure on page 165 shows just this. The author points out the necessity of improvement in the matter of this anchorage and suggests the use of punched vertical steel angles, but he does not show this in his figure and thus depart from standard, illogical design.

This treatment of the counterforted retaining wall appears to be an attempt to justify some existing design, as the figure departs so radically from the theory of such walls as developed by the author. Take, for example, the vertical slab. This is reinforced all the way from top to bottom with continuous rods near both front and back face, with equal area of steel. His theory shows only an outward load, which would require only one-half of this reinforcement. Similarly, the base slab is reinforced near both top and bottom all the way and even under the vertical wall, where no bending could possibly exist; the rest of the slab could have only one sign of bending moment.

Professor Cain calls the counterfort a triangular beam. He applies the intricate theory, to which he devotes 35 pages in his appendix, to the solution of this beam. Then he finds that the design is all the way to 50% too strong; this does not show much confidence in the theory nor a need of one so complex.

*Structural Engineer, Robert W. Hunt & Co., Pittsburgh, Penn.

The reviewer pointed out a number of years ago that the counterfort of a retaining wall is not a beam, but merely the concrete covering of tie-rods connecting the vertical slab and the horizontal slab. Professor Cain considers this counterfort as a beam, though in his solution he ignores one great force—namely, the shear—applied externally along the front edge, adjacent to the vertical slab.

The author has carried standard nomenclature to an extreme, scattering the values through the volume, a thing very annoying to the user of the book who has not time to make a week's study. For example, to use the tables of retaining walls on page 116 one must refer to page 107 for several of the values; page 89 tells the meaning of K; page 94, of K_1; page 22, Fig. 6, of a; on page 113 one can learn the meaning of A, by reading the text and guessing it; on page 110 one learns that the wall is 1 ft. high. Would it not be better for an author to use the first letters that come into his head for these values and explain their meaning close to the table, so that the user, who has not time to read or review the whole book, may readily get their meaning?

The pressure of earth that is found in nature (not dry sifted and washed sand of laboratory experiments) is so variable and unknowable that fine theories seem ridiculous. Most fills will stand against a board fence until frost or a heavy rain exerts forces not in the theory at all. But the same stability that will resist frost and a lubricated wedge of mud will be supplied if the fill be considered a liquid of a weight say one-sixth, or one-quarter, or some other fraction of the actual weight of the fill. In fact, this fraction can be selected or computed to give practically identical results with the fine-spun theory, and the equivalent fluid-pressure method is immensely easier of application. As a trial, the reviewer worked out the forces for the coal bin on page 227 by the simple method. They were near enough to those found by Professor Cain to give identical results in the design.

On page 127 a section of a retaining wall cut from point A downward to the right does not touch any steel, though this section is under heavy bending stress. The same is true of the figure on page 140. The reviewer has publicly pointed out many times this common blunder in the design of L- and T-shaped retaining walls.

On page 163 the author speaks of the little rods in a counterfort "acting like stirrups in resisting diagonal tension." Until some champion arises who can explain how stirrups perform this office it would be better to use anchored diagonal rods, whose action is quite simple and positive.

Many public-service commissions furnish newspapers with authentic but unofficial typewritten abstracts of their various important activities, but the Illinois Commission appears to be the first with an official printed monthly bulletin intended for general distribution. No. 1 appeared under date of Apr. 1. Besides notes on important cases finished, there is a complete list of orders entered.

Steel Heat Treatment

STEEL AND ITS HEAT TREATMENT—By Denison K. Bullens, Consulting Metallurgist. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. vii + 431; 223 illustrations. $3.75 net.

REVIEWED BY C. J. YARNALL*

The heat treating of steel has developed so rapidly in the past few years that the small as well as the large manufacturer has found it necessary to install a special department, equipped with competent men and appliances for the treatment of material and the careful checking of temperatures. The steel trade has demanded a steel with a high efficiency, to withstand constant vibration and shock and at the same time keep the section down to a minimum, to reduce not only the cost, but the weight.

Heat treating meets this requirement. High- as well as low-grade steels will give a higher ultimate strength, better ductility and a finer molecular structure after being intelligently treated than in their normal condition, as is proved by the book under review. The book is profusely illustrated, and the various points in the manufacture and treating of steel are ably portrayed by the writer. A collection of valuable information is found between its covers, not only to the professional man, but to the layman as well.

Beginning with the low-carbon steels and gradually working into the high-carbon and alloy steels, critical ranges are given, methods of quenching and temperatures for the drawback, construction of furnaces, etc.

Modern requirements demand some very large solid forgings on which it would be interesting to have data. This book deals lightly with anything larger than a car or locomotive axle, but as a whole it is valuable.

Gas-Engine Ignition

GAS-ENGINE IGNITION—Prepared in the Extension Division of the University of Wisconsin by Earle B. Norris, M. E., Associate Professor of Mechanical Engineering; Robert K. Winning, B.S., Assistant Professor of Electrical Engineering, and William C. Weaver, B.S., Research Engineer, Western Electric Co.; formerly Instructor in Electrical Engineering. New York: McGraw-Hill Book Co. [Engineering Education Series.] Cloth; 6x9 in.; pp. ix + 174; 209 illustrations. $1.50 net.

Few engineers realize the development reached in the art of firing fuel charges in internal-combustion engines—for indeed it is a distinct line of effort in which apparatus designed and manufactured by a few specialists is used by the great army of engine manufacturers the country over. This book will acquaint any intelligent man with this field, be he graduate engineer or factory employee. The text evidently has been very carefully prepared with a view to home study, and is worthy of the stamp it bears "prepared in the Extension Division of the University of Wisconsin."

The older schemes like hot-tube ignition are quickly passed over to get at the various electric-spark systems, which are grouped under such main topics as jump-spark battery equipment, low-tension magnetos, high-tension magnetos and direct-current machines. The chapter grouping is split up into smaller complete elements, however, for promoting study. Great attention is paid to the details of various commercial magnetos and their interrupters and spark distributors. There are a few chapters on such elementary matters as batteries, generation of electromotive force, direct and alternating currents.

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Panama Canal Construction

THE CONSTRUCTION OF THE PANAMA CANAL—By William L. Sibert, Brigadier-General, U. S. A., formerly Member of the Isthmian Canal Commission and in charge of the building of the Gatun locks and dam and of the channel from Gatun to the Atlantic Ocean, and John F. Stevens, formerly Chief Engineer and Member of the Isthmian Canal Commission. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. x + 339; 23 illustrations. $2 net.

THE PANAMA CANAL: An Engineering Treatise—Prepared by engineers and other specialists in charge of the various branches of the work and presented at the International Engineering Congress, San Francisco, Calif., 1915; under the direction of George W. Goethals, M. Am. Soc. C. E., Major-General, U. S. A., Governor of the Canal Zone, formerly Chairman and Chief Engineer, Isthmian Canal Commission. A series of papers covering in full detail the technical problems involved in the construction of the Panama Canal—geology, climatology, municipal engineering, dredging, hydraulics, power plants, etc. In two volumes. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. 527 and 483; numerous text illustrations and folding plates. $7.50 per set.

In writing a book on the Panama Canal the puzzle is to know what to put in and what to leave out. Within the limits of the single modest volume by General Sibert and Mr. Stevens no very complete story of the canal work was of course possible. What the authors have done is to give a sort of birdseye view of the work of construction, presenting the facts and figures which are of most general interest.

General Sibert is the author of the introductory chapter containing a rapid sketch of the changes in personnel of the canal's working force, from the appointment of the first canal commission on Mar. 3, 1904. Former Chief Engineer Stevens contributes the following six chapters, which cover the preparatory period from the beginning of operations in 1904 to the transfer of the task to the army engineers in March, 1907. Mr. Stevens uses much of his space to review the controversy over the question whether the canal should be built at sea level or with locks and then describes the important preliminary work, such as the rebuilding of the Panama R.R., the development of working plans and the assembling, control, housing and feeding of the labor forces. General Sibert is the author of the remaining chapters, which cover the period from March, 1907, to April, 1914. His chapter on the construction of Gatun dam is especially noteworthy, as there are a number of events in connection with the building of this greatest of hydraulic-fill dams which have not been generally known and which General Sibert here puts on record.

The publishers of the book have shown poor judgment in issuing it with uncut edges, so that the reader has to use a paper cutter continually. A book of this sort, to be read by busy men, should never be issued in such form.

The papers on the Panama Canal which were presented at the International Engineering Congress held at San Francisco in September last have been printed in two volumes. By a special arrangement with the managers of the congress, the two volumes (which are distributed free to those engineers who originally became members of the congress and made the selection of these volumes as their choice of the publications) are now made available to others.

Most of the numerous books which have been published on the Panama Canal have given comparatively little attention to the technical engineering features. This publication is therefore the first complete technical account of the engineering work of the Panama Canal. There are in the two volumes 25 different papers, and the authors include most of the leading engineers who were responsible for the design and execution of the work. The intro-

duction is by General Goethals, who contributes also paper No. 10—on the dry excavation of the canal—a chapter which would of course have been written by the late Colonel Gaillard, except for his untimely death.

The titles and authors of a few of the chapters will give an idea of the scope of the work: Dr. Emory R. Johnson discusses the commercial and trade aspects of the canal; Canal Zone geology is treated by Donald S. Macdonald; sanitation by Charles F. Mason; municipal engineering by Henry W. Durham and George M. Wells; the purchase of supplies for the canal is described by Major Boggs. The Gatun locks, dam and spillway are described by General Sibert, and the corresponding works on the Pacific division by S. F. Williamson. Papers on the locks and different features connected with them are contributed by General Hodges, L. D. Cornish, Henry Goldmark and R. H. Whitehead. Admiral Rousseau describes the terminal works, dry docks and wharves, and F. H. Cooke the coaling plants and floating cranes.

It is of great value to have the technical data accumulated in the Panama Canal work made available to the profession. These books should certainly find a place in every engineering reference library.

World Doings in 1915

THE NEW INTERNATIONAL YEAR BOOK: A Compendium of the World's Progress for the Year 1915—Editor, Frank Moore Colby, M. A.; Associate Editors, Allen Leon Churchill and Horatio S. Krans, Ph.D. New York: Dodd, Mead & Co. Cloth; 7x10 in.; pp. 752; illustrated. $5 net.

THE AMERICAN YEAR BOOK: A Record of Events and Progress, 1915—Edited by Francis G. Wickware, with Cooperation of a Supervisory Board Representing National Learned Societies. New York: D. Appleton & Co. Cloth; 5x8 in.; pp. 862. $3.50.

Each of these excellent annuals follows the general plan of former years. The "International" is "an encyclopedia of the year, with the titles arranged in a single alphabet." The "American" presents its material under thirty-three department heads, such as "American History," "Municipal Government," "Manufactures," "Engineering," "Literature and Language," with many subheads under each department—the whole followed by a long, detailed index. As the titles imply, the "International" is broader in general scope than the "American," but the departmental plan of the "American" enables it to present summary reviews of a whole scientific or other field of knowledge. Each plan has its advantages and it is fortunate that with two such good yearbooks in the field different plans are employed. The engineering articles are a feature of each annual. The "International" alone has illustrations. Both contain much statistical matter.

Descriptive Geometry

PRACTICAL DESCRIPTIVE GEOMETRY—By William Griswold Smith, M.E., Assistant Professor of Descriptive Geometry and Kinematics, Armour Institute of Technology. Second edition, revised, enlarged and reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. x + 256; 187 illustrations. $2 net.

Taking advantage of suggestions received from various users of the first edition since the book was published in 1912, the author, according to his preface, has made a number of changes in the present edition, the most important of which he states as follows:

1. The division into more chapters.
2. A more logical sequence of certain portions of the text.
3. The notation of points and planes.
4. Graphic layout for exercises.
5. More exercises of a practical nature, embracing more lines of engineering endeavor.
6. Number of new solutions, utilizing auxiliary planes more frequently.
7. A better system of perspective drawing.
8. A chapter on the intersection of plane solids.

On weighing various suggestions (mostly from architects) as to the treatment of perspective in the new edition the author chose conical projections, a process which he says "is sane, in that it is a direct application of principles of descriptive geometry, and is easy and swift in operation."

A review of the first edition of this book appeared in *Engineering News* for Mar. 13, 1915.

The Engineer in Fiction

THE STRANGE CASES OF MASON BRANT—By Nevil Monroe Hopkins. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 304; illustrated. $1.25 net.

Professor Hopkins, the versatile teacher-engineer of George Washington University, has produced here some very entertaining and creditable detective stories of the Conan Doyle order—with a little more emphasis on the fiendish use of science in crime. The volume contains the record of three cases in which the cunning of Mason Brant (very like Sherlock Holmes in his keen powers of observation and deduction) unravels a murder mystery and clears the name of a beautiful girl—for some one else to woo and win.

The last tale while the most successful as a detective yarn also possesses a certain charm, at least for ardent young engineers, with its depicting of fateful circumstances that repeatedly threw together a winsome miss and a wholesome boy just out of his technical school. The first meeting was when the girl's Pullman on the New Haven road stopped opposite a tower that the hero was inspecting and brought her blushingly face to face with him—and a big monkey wrench. The last meeting leads to the tender admission that the boy, about to become chief electrical engineer of the electrified New Jersey Central, has become, in the girl's words, "as deeply a part of me as the color is of the rose."

Concrete-Road Construction

PROCEEDINGS OF SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING, Held at Chicago, Feb. 15-18, 1916—Chicago (111 West Washington St.): J. P. Beck, Secretary. Paper; 6x9 in.; pp. 328; illustrated. $1.

In the discussions in the conference whose proceedings are reported in this volume, this report was several times referred to as the Bible of the concrete-road engineer. No engineer interested in any way in the construction of highways or street pavements can afford to be without this report any longer than the time required to send for and receive it. The art of concrete-road construction has developed so rapidly during the past two years that none of the standard textbooks on road construction present uptodate information on this subject. The rapid advance of the concrete road in public favor and the great improvement in its quality, as a result of careful attention to such details of practice as are covered in this volume, are facts that should be known to every highway engineer.

Of course, the volume is not a treatise nor a pocketbook. The committee reports and discussions present a diversity of views on many topics, and the reader will be obliged to study carefully the opposing views and form his own conclusions.

Public Health Protection

AMERICAN PUBLIC HEALTH PROTECTION—By Henry Bixby Hemenway, A.M., M.D., author of "The Legal Principles of Public Health Administration," etc. Indianapolis, Ind.: The Bobbs-Merrill Co. Cloth; 5x8 in.; pp. 283. $1.25 net.

A wide reading of this book by those interested in improving public-health administration, but uninformed or misinformed as to what uptodate health-protective work is and how it can best be carried out, would be a great benefit to the whole country. The author has a true conception of these matters and puts his ideas in an interesting and forcible way. His book is nontechnical.

After a sketch of the development of public-health work in this and other countries and an outline of present-day health agencies in the United States, the author compares medical and sanitary education and shows how far the former falls short of meeting public-health needs. Changed social, economic and scientific conditions in their relation to health problems are noted. There are chapters on medical inspection of schools, health-department organization and the training of health officers.

As a whole, the book is notably sane, progressive and free from apparent errors. A few sentences on sewage disposal may mislead the uninformed, chiefly as regards the Imhoff tank.

British Sewer-Pipe Standards

BRITISH STANDARD SPECIFICATION FOR SALT-GLAZED WARE PIPES—The Engineering Standards Committee; Leslie S. Robertson, M. Inst. C. E., Secretary. London, England: Crosby Lockwood & Son. Paper; 8x13 in.; pp. 10. 5s. net.

A sectional committee on vitrified pipe was appointed in May, 1911, by the committee mentioned in the foregoing title. The report was completed three years later and published in August, 1914, but by inadvertence has not been given well-deserved notice in these columns. The sectional committee was composed of thirty-three members representing the British Government, Crown Agencies for the Colonies, the London County Council, several cities, many societies, and also pipe manufacturers. Sir Maurice FitzMaurice was chairman. A draft of a standard specification proposed by a committee of the Institution of Municipal and County Engineers and another draft of specifications proposed by a committee of manufacturers were considered in framing the specifications here presented, which have been approved by both the sectional and general committees. The specifications proper fill only five pages of large open type, besides which there is a table of joint dimensions.

Engineers and Military Service

THE ENGINEER IN WAR; With Special Reference to the Training of the Engineer to Meet the Military Obligations of Citizenship—By P. S. Bond, M. Am. Soc. C. E., Major, Corps of Engineers, United States Army; Honor Graduate, Army Field Engineer School; Graduate, Army Staff College. [Reprinted, with revisions and additions, from "Engineering Record."] New York: McGraw-Hill Book Co. Flexible leather; 5x7 in.; pp. xv + 187; 70 illustrations. $1.50 net.

Books like this one of Major Bond's and the earlier one of Captain Robinson are of special interest to engineers at this time—forming as they do a permanent record of lecture courses given in several cities of the country. Such a record is obviously better than a carefully prepared transcript of scratch notes. The scope of these courses is now so well known that the ground covered by this little volume can be stated by saying that it follows the lectures, in showing civilian engineers what military engineering comprises and how everything is subordinated to tactical considerations. The discussions open with the military policy of the United States and close with the military duties of citizenship. In between are found a few such specific topics as tools, stream crossings, roads, field fortifications, reconnaissance mapping, demolitions and camp sanitation.

Novel Electrical Textbook

ELECTRICAL ENGINEERING FIRST COURSE—By Ernst Julius Berg, Professor of Electrical Engineering, and Walter Lyman Upson, Associate Professor of Electrical Engineering, Union College, Schenectady, N. Y. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 416; 296 illustrations. $4 net.

Teachers of electrical engineering may be surprised to hear of a text by these authors, on account of their known objections to prescribed texts. Their effort here has been to make this text a concise record of ideas that should sink in during lectures rather than a full and clear exposition, which treatment they reserve for oral presentation in the classroom.

The book contains a large number of problems, many worked out fully or in part, so that the student has an example, a record, of how an engineer attacks engineering work. There is no particular novelty in the ground covered—direct-current generators and motors coming first (with a few necessary fundamental topics), then the ballistic galvanometer, alternating-current waves, symbolic method in calculations, properties of alternating-current circuits, the wattmeter, electrostatics and finally alternating-current machinery. Mathematical expression is not spared.

Chemists' Handbook

THE METALLURGISTS' AND CHEMISTS' HANDBOOK: A Reference Book of Tables and Data for the Student and Metallurgist—Compiled by Donald M. Liddell, Consulting Metallurgical Engineer and Sometime Managing Editor of "The Engineering and Mining Journal." New York: McGraw-Hill Book Co. Flexible leather; 4x7 in.; pp. vii + 603. $4 net.

The data presented by Mr. Liddell have been selected in part as the result of experience with readers of the *Engineering and Mining Journal* which must have promoted an intelligent and happy choice of material. There are first given tables of weights and measures, and mathematical quantities. Then there are statistics of the price and production of various metals. Physical constants of common metals, gases, chemicals, etc., are assembled in one section and followed by a summary of chemical laws and practices, and data therefor. There are also sections on sampling and assaying, ore dressing, cyanidation, general metallurgy, fuels and mechanical engineering, the latter covering such pertinent topics as belt conveyors, standard pipe fittings, ropes and chains, knots and hitches, compressed air, cost of buildings, etc.

Some Eminent Mechanics

ENGLISH AND AMERICAN TOOL BUILDERS—By Joseph Wickham Roe, Assistant Professor of Machine Design, Sheffield Scientific School, Yale University. New Haven, Conn.: Yale University Press. Cloth; 7x10 in.; pp. xv + 315; 57 illustrations. $3 net.

The author has evidently been impressed with the great debt that modern industry owes to a few great mechanics, eminent tool builders, and has with this attractive volume made a formal history of their work. Only Englishmen and Americans are considered, the author holding that the French have been only ingenious adapters, the Swiss skilled operators and the Germans not developed before

the important tools took shape. The book really traces the rise of tool building. Among the many men whose names stand out are Bramah, Bentham, Brunel, Maudslay, Clement, Whitworth, Nasmyth, Murray, Fox and Roberts in England, and Colt, Whitney, North, Lawrence, Stone, Howe, Hartness, Darling, Pond, Putnam, Evans, Sellers, Bement, Warner and Swasey in America.

New York Highway Guide

OFFICIAL BULLETIN FOR 1915, NEW YORK STATE COMMISSION OF HIGHWAYS—Albany, N. Y. Paper; 6x9 in.; pp. 357.

Engineers who are interested in highway construction and who may wish to visit New York and examine the state road work should by all means secure a copy of this bulletin. It is made up of tables giving for every highway in the state its number (which can also be found on the sign post at the side of the road), length in miles, width of pavement and of roadway, materials used in construction, date when the contract was let, date of acceptance of the road, year when the pavement was resurfaced, pavement at present on the road and the cost per square yard of pavement and per mile of 16-ft. highway. Other tables list the highways by counties, show the status of through state routes, status of highways under contract and awaiting contract, and contracts for repairs.

Hydrated Lime for Masonry

HYDRATED LIME; HISTORY, MANUFACTURE AND USES IN PLASTER, MORTAR, CONCRETE: A Manual for the Architect, Engineer, Contractor and Builder—By E. W. Lazell, Ph.D., M. Am. Soc. M. E. Pittsburgh, Penn. (Arrott Building): Hydrated Lime Bureau. Paper; 6x9 in.; pp. 95; illustrated.

The processes of manufacture of hydrated lime, the properties of the material and the methods of its application to various kinds of masonry work are not too well understood by engineers and contractors. This book has been prepared to supply such a need. It is particularly strong in the history of hydrated lime and the methods of its manufacture. The value of the material in its later application—that is, in making concrete more plastic and waterproof—is not so thoroughly entered into, probably because the amount of information available on these latter subjects is still quite meager.

American Steel Trade Directory

DIRECTORY OF THE IRON AND STEEL WORKS OF THE UNITED STATES AND CANADA, 1916—New York, The American Iron and Steel Institute (61 Broadway): James T. McCleary, Secretary. Cloth; 6x9 in.; pp. 437. $12.

For many years the late James M. Swank, as Secretary of the American Iron and Steel Association of Philadelphia, compiled and published annually a directory of the iron- and steel-making plants of the United States, which was a much-valued reference book. At Mr. Swank's death, the work was given up; but the need for such a volume compiled by a responsible authority has been so great that its publication has been resumed by the American Iron and Steel Institute, of which James T. McCleary is Secretary. It is eight years since the last revision of Mr. Swank's work was published. Since that time, the changes in the industry have been so many and so sweeping that the present volume is an entirely new book. In place of the geographic arrangement of former directories, most of the space in this work is taken up with a list of the properties owned by the different iron- and steel-making companies, arranged in alphabetical order. Supplementing this are four lists, each arranged geographically, of blast furnaces, steel-making plants, steel foundries and rolling mills. Then follow lists of manufacturers of twenty different classes of iron and steel products, such as billets, bars, structural shapes, wire rods, black sheets, muck bar, tool steel, rails, seamless tubes, nails, etc. By the use of a system of abbreviations, it has been possible in comparatively small space to present for each works listed a fairly complete statement of its equipment, furnaces, machinery, etc., and its annual capacity. The Iron and Steel Institute is to be congratulated on this publication.

Howe's Cast Iron and Steel

THE METALLOGRAPHY OF STEEL AND CAST IRON—By Henry Marion Howe, Professor Emeritus of Metallurgy in Columbia University. New York: McGraw-Hill Book Co. Cloth; 7x11 in.; pp. xxviii + 641; 123 text illustrations, 45 plates. $10 net.

REVIEWED BY F. N. SPELLER*

Professor Howe's new book is indeed a monumental treatise. It contains the results of much original work. It abounds with new hypotheses and ideas that cannot fail to stimulate the thoughtful reader. Each of the many topics considered is thoroughly treated. There are some chapters dealing with the more abstruse phases of this complex subject that the average metallurgical reader will probably pass over for the present. The text is expressed with the author's well-known clearness and purity of style.

The title seems altogether too narrow for the field covered; or, to put it in another way, the author has forced the boundaries of metallography out and laid the way open for a broader scope for this science.

A large index and 45 plates, each one averaging several good-sized microphotographs, are inserted at the back of the book. These illustrations are well prepared and clearly reproduced, but the hurried reader will probably wish that they had been scattered appropriately throughout the text.

Those who read any considerable portion of the book will undoubtedly join with the reviewer in wishing the author similar success in the preparation of the series of volumes to follow on allied subjects.

Useful Set of Rate Tables

STANDARD IMPROVED RATE TABLES for Manufacturers, Engineers, Bankers, Brokers, Contractors and Shippers—Calculated by John W. Marshall. New York: Boorum & Pease Co. Cloth; 7x9 in. $4.

The prime purpose of the rate tables is to facilitate rapid calculation of the earnings of employees. Given a man's hourly rate and the number of hours he worked, to find his total earnings is a matter of merely turning to the right page. The latter is easily done by the aid of a thumb index of hourly rates running from 10c. to 80c. For example: If a man is earning 31½c. an hour and it is desired to know what is due him for 16½ hr. work, turn to the section thumbed "32" and on the left-hand page opposite 16½ will be found $5.20. Similar tabulations are given for those paid on a weekly or a monthly basis.

These tables can be employed elsewhere than in the timekeeper's office—for instance, the cost of freight on any number of pounds or tons at a given rate can easily be computed. In short, these are rate tables, which means that whenever the rate and the quantity are known, the total cost can be determined at a glance.

*Metallurgical Engineer, National Tube Co., Pittsburgh, Penn.

Novel Logarithm Tables

FIVE-FIGURE MATHEMATICAL TABLES, Consisting of Logs and Cologs of Numbers from 1 to 40,000; Illogs (Antilogs) of Numbers from 0.0000 to 0.9999; Lologs (Logs of Logs) of Numbers from 0.00100 to 1.000; Illologs (Antilologs) of Numbers from 6.0 to 0.5000, Together with an Explanatory Introduction and Numerous Examples; also, Trigonometrical Functions and Their Logs of Angles from 0° to 90° at Intervals of 1 Minute, with Subsidiary Tables —Compiled by E. Chappell, B.Sc., A. C. G. I., Assoc. M. Inst. C. E., Temporary Naval Instructor R. N., Late Lecturer in Engineering at the City and Guilds' (Engineering) College, Imperial College of Science and Technology, London, S. W. London: W. & R. Chambers. [New York: D. Van Nostrand Co.] Cloth; 6x9 in.; pp. xvi + 320. $2 net.

Special tables for exponential calculations make this book a new appearance among logarithm tables. The author has computed logarithms of logarithms (loglogs), and their inverse, or antiloglogs.

The use of these two new tables involves a peculiar difficulty. There are two sets of anti-values for a given loglog, corresponding to positive and negative values of the intermediate stage or simple log, or to numbers greater and less than 1. To meet this difficulty, the antiloglog table is arranged in duplicate, one with the entry figures printed in red (for anti-values below 1.0), the other with the same figures printed in black. Similarly the loglog table is printed in red for entry values below 1.0, and in black for the remainder. The intervals of both tables are varied in striking manner to suit the different conditions of accuracy and the different requirements of use.

The book also contains, besides an ordinary log table, a table of cologs, which in itself is a rarity. It also has values and logarithms of the trigonometric functions, and here the author again is iconoclastic. The table runs 89° and gives sin, log sin, tan, log tan, sec and log sec; of course, the co-functions are read from the same figures, starting from the bottom of the page, where the complementary angles are printed.

The author is not merely original, as the foregoing proves, but he attempts to reform terminology. For "antilog" he says "illog," for "loglog" he says "lolog," and for "antiloglog" he says "illolog." These innovations do not reduce the value of the tables.

Engineering Profession

ENGINEERING AS A PROFESSION—By Milo S. Ketchum, C.E., Dean of the Collage of Engineering. Boulder, Colo.: University of Colorado. Bulletin No. 98. Paper; 5x8 in.; pp. 27.

In this little pamphlet are reprinted five brief papers by Professor Ketchum, the titles of which are: "Why Go To College?" "The Value of a Technical Education"; "The Making of an Engineer"; "The Field of the Engineer"; "Opportunities of the Engineer." Professor Ketchum's opinions on the much discussed subject of the status of the engineering profession and its outlook for the future will doubtless be read with interest by a much wider circle than the students for whom the articles were originally written.

Technical-Periodical Index

THE INDUSTRIAL ARTS INDEX: Subject Index to a Selected List of Engineering and Trade Periodicals for 1915—Edited by Marion E. Potter, Louise D. Teich and Helen M. Craig. Third Annual Cumulation. White Plains, N. Y.: The H. W. Wilson Co. Cloth; 7x10 in.; pp. 509.

The present is the largest and most complete of the three annual volumes of the "Industrial Arts Index" thus far issued. This publication is rapidly gaining recognition as the best general index of technical literature available, and deservedly so as it seems to be compiled with care and reasonable thoroughness.

The main scheme of the index is to distribute the subjects covered under many headings of restricted scope, avoiding numerous entries under broad general headings. For instance, in this volume to find an article on Imhoff tanks it is not necessary to turn to Sewage Disposal and look through a long list, but merely to look under Imhoff Tanks. In short, the scheme is to index under the key word of the title and not under the general subject heading.

Carried out understandingly, this makes the most handy kind of index for quick and ready reference; but thus to carry it out requires that the indexer have more knowledge of the article than can be had from reading the title. The writer who describes an Imhoff tank sewage-disposal works and inadvertently fails to bring Imhoff tank into the title will find his article not under Imhoff Tanks, but under Sewage Disposal. Under Imhoff Tanks he will find no cross-references to articles mainly on Imhoff tanks, which are entered under Sewage Disposal.

Again, there is always the likelihood that indexers unfamiliar with engineering practice will separate the same or similar work because it is described under different headings, which are practically synonymous. Such headings, for instance are water conduits and aqueducts. It is not unlikely that two articles on the same structure would thus be separated solely owing to a matter of taste in the one who wrote the title.

However, it is believed that these disadvantages are less serious than those of broad classifications, for the regular use of an index soon makes one so familiar with the indexer's methods as to be able readily to trace out all possible headings that are likely to contain articles bearing on the subject in question. These idiosyncrasies of every indexer, however, illustrate why no printed book index can ever serve the same purpose or be of the same value as a card index compiled by the person who uses it and who knows the subject he is indexing.

One feature particularly to be commended in the "Industrial Arts Index" is the indexing of articles under localities as well as under subjects.

Park Engineering

PARKS AND PARK ENGINEERING—By William T. Lyle, Assoc. M. Am. Soc. C. E., Professor of Municipal Engineering at Lafayette College. New York: John Wiley & Sons, Inc. Cloth; 6x9 in.; pp. viii + 130; 38 full-page plates. $1.25 net.

Considering how much money has been expended in the acquisition and development of public parks during the last few decades, the meagerness of the printed matter on the practical aspects of park acquisition and construction is remarkable. Professor Lyle has therefore done well to expand his park lectures to students of municipal engineering and publish them in book form. Although designed primarily for young engineers engaged in park work, the author also had in mind some engineers older in years but not in experience, as well as park commissioners. He has modestly refrained from encroaching on the cherished domain of the landscape architect, but gives a few accepted landscape principles.

The book opens with a few pages on the desirability and classification of parks, how to set the getting of them in motion, and the necessary topographical and hydrographical surveys. The author next considers the design of

underdrains, sewers, paths, drives and other engineering features. The choice between day labor and contract work, together with contract letting and supervision, is next taken up. Finally there is a chapter on construction.

The book fulfills the author's purpose so well that it is to be hoped he will soon have an opportunity to enlarge it, particularly along lines of engineering design and construction that have been modified to meet park-work needs.

⁂

Gas Engineering Practice

PROCEEDINGS OF THE INTERNATIONAL GAS CONGRESS Held at San Francisco, Calif., Sept. 27-Oct. 2, 1915. New York (29 W. 39th St.): George G. Ramsdell, Secretary. Cloth; 6x9 in.; pp. 670; illustrated.

Like most of the other congresses held in San Francisco last fall, the International Gas Congress was international chiefly in name. It did bring together, however, a notable assemblage of the leading gas engineers of the United States, and the papers presented form a summary of uptodate practice in gas engineering. Nothwithstanding the fact that many gas companies are controlled by electric lighting interests, the "Proceedings" of the Congress indicate that gas is being actively pushed as an illuminant in competition with electricity. Besides the technical papers, considerable attention was given in the Congress to the discussion of the relations of the companies to the public and to regulating bodies.

⁂

Commission-Manager Charter

A MODEL CITY CHARTER AND MUNICIPAL HOME RULE, as Prepared by the Committee on Municipal Program of the National Municipal League (North American Building, Philadelphia, Penn.) Paper; 6x9 in.; pp. 59. 50c.

As far back as 1900 a committee of the National Municipal League, after several years of work, completed and the league adopted a model city charter of the so-called Federal type. It provided for a mayor and city council, with all legislative powers vested in the latter and executive powers in the former. Shortly after the model charter of 1900 was adopted, the Galveston storm and flood ushered in the commission plan of city government; and strangely enough, a dozen years or so later the Dayton flood, while not initiating the commission-manager plan, did bring it prominently to the front.

About the time of the adoption of the Dayton charter the National Municipal League created a new Municipal Program Committee, of which M. N. Baker, of the editorial staff of *Engineering News* was a member. That committee has drawn up a new model city charter providing for the commission-manager plan of government and giving prominence also to municipal home rule.

The new model charter follows pretty closely in its general features the now fairly familiar type of commission-manager charter as exemplified at Dayton and elsewhere. Great care has also been given to the section on "Municipal Franchises," and a short section on "City Planning," drafted by Mr. Baker, has been added.

⁂

Power Test Committee Rules

RULES FOR CONDUCTING PERFORMANCE TESTS OF POWER-PLANT APPARATUS—Report of Power Test Committee. New York (29 West 39th St.): American Society of Mechanical Engineers. Paper; 6x9 in.; pp. 215; 27 illustrations.

The Power Test Committee of the American Society of Mechanical Engineers was appointed in 1909 to revise the old codes of the society relating to tests of boilers, pumping engines and other power apparatus, and to extend the code to apply to new forms of power apparatus, including water power. The committee consisted of George H. Barrus, D. S. Jacobus, William Kent, Albert C. Wood, Edward F. Miller, L. P. Breckenridge, Arthur West and Edward T. Adams. It presented a preliminary report in December, 1912. This report was widely distributed, received extended discussion and criticism and has now been finally revised. The code covers tests of boilers, reciprocating steam engines, steam turbines, pumping machinery, compressors, blowers and fans, complete steam-power plants, locomotives, gas producers, gas and oil engines and waterwheels. Besides the code proper, appendices covering some 50 pages discuss special subjects in connection with power-plant testing. The council of the society on Dec. 7, 1915, voted to appoint a permanent committee to interpret this code when called upon to do so, make revisions when found desirable and modify the rules to meet new conditions as they may arise in the future.

⁂

Detailed studies of the rainfall records of a single city, designed primarily for engineers, are not so common but what a hearty welcome will be accorded to a couple of thin pamphlets under the title, "Rainfall Data of Berkeley, California" (University of California Publications in Engineering, Vol. 1, No. 5 and No. 6, pp. 69-81 and 83-116). The first pamphlet, by W. G. Reed, gives monthly, seasonal and intensity figures for the period 1887 to 1914. The second pamphlet, by Mr. Reed and Marshall K. White, summarizes intensity studies based on the records of the recording rain-gage of the Engineering Department of the University from 1911 to 1915.

⁂

Maps of the United States for 1, 5 and 15c. each, according to size and detail, with reductions for wholesale orders, are offered by the United States Geological Survey, Washington, D. C. By a recent ruling, postmasters are now permitted to handle Geological Survey maps and are allowed a small commission on their sales. This will doubtless prove to be a great convenience to many, particularly in the smaller places of the country.

⁂

The surprising amount of information that can be got together on what at first might appear to be a minor detail of engineering practice is illustrated by a hundred-page pamphlet entitled "Highway Bridge Floors," recently reprinted from Vol. 31 of the "Proceedings" of the Engineers' Society of Western Pennsylvania. The pamphlet consists of a lengthy paper read before the society on Nov. 9, 1915, by Charles M. Spofford, Professor of Civil Engineering, Massachusetts Institute of Technology, followed by considerable discussion by members of the society named. Drawings and halftone views illustrate the paper.

⁂

A card-index form to announce newly published books is being used by John Wiley & Sons. The date of publication appears on the top of the card, followed by the surname of the author and the title of the book as a catchline. The full name and title of the author follow, together with the size and price of the book and a brief summary or description of its contents. On the reverse side of the card a complete table of contents is given. Of course, the name and address of the publisher are also made known. These cards may be filed under the name

of either the author or the book and may serve as a reminder of possible books to be purchased, or they may form the nucleus of a card catalog.

⁂

Two recent pamphlet reprints from the "Journal of Agricultural Research" of the United States Department of Agriculture are of unusual interest to hydraulic engineers. One (Vol. 5, No. 24) describes a new irrigation meter consisting of a self-cleaning weir, easily built and operated and accurate. The velocity of entering water increases until it passes the weir notch; the box has only a quarter the depth for a full contraction weir. The second booklet (Vol. 5, No. 23) shows the results of an investigation into the Francis and Cipoletti formulas for the small weir sizes used in irrigation service. Briefly summarized, the older formulas give results within 1½% (Cipoletti) and 2% (Francis) of actual discharges; new formulas are deduced that agree more closely.

⁂

As a possible guide for the city- and town-planning boards required by law in Massachusetts, "A Schedule of Civic Surveys" has been prepared by Arthur C. Comey, a member of the Homestead Commission, and is being distributed by the commission (N. F. Sterling, Secretary, State House, Boston, Mass.). The main divisions of the schedule are as follows: (1) Underlying factors, including physical conditions or sources and use of land; (2) circulation, including streets, transportation, utilities, food supply and disposal; (3) public affairs, embracing administration of health, education and recreation; (4) social conditions, including housing, work, welfare and nuisances; (5) finances and law. The bulletin contains some commendable suggestions regarding the maps that should be provided in connection with a civic survey.

⁂

The work of the United States Lighthouse Service is too little appreciated by either the general or the engineering public. The service is well organized and is carrying out in admirable fashion the guarding of the coasts, large lakes and rivers of the United States. For the benefit of those who are anxious to learn the details of the Lighthouse Service work a book entitled "United States Lighthouse Service" has been published by the Department of Commerce. (Superintendent of Documents, Washington, D. C.; 15c.)

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

THE ALASKAN MINING INDUSTRY IN 1915—By Alfred H. Brooks. Bulletin 642-A, United States Geological Survey. Washington, D. C. Paper; 6x9 in.; pp. 71.

CORRECTION OF ECHOES AND REVERBERATION IN THE AUDITORIUM, UNIVERSITY OF ILLINOIS—By F. R. Watson and James M. White. Urbana, Ill.: Engineering Experiment Station, University of Illinois. Bulletin No. 87. Paper; 6x9 in.; pp. 20; illustrated. 15c.

Besides the subject matter mentioned in the title this pamphlet contains an extension of the bibliography printed in Bulletin 73 of this series, entitled "Acoustics of Auditoriums."

EXCERPTS FROM THE FIRE PREVENTION LAWS AND ORGANIZATIONS OF EASTERN CITIES with Recommendations for Establishing a San Francisco Bureau of Fire Prevention. (From Report by Heller & Wilson, Consulting Engineers.) San Francisco: Board of Fire Commissioners. Paper: 8x11 in.; pp. 36.

THE EXTENT TO WHICH SEWAGE CAN BE PURIFIED BY PRACTICAL METHODS OF ARTIFICIAL TREATMENT NOW IN USE—Reprinted from the Proceedings of the Engineers' Society of Western Pennsylvania, Vol. 32, pp. 226-270. By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, Boston, Mass. Paper; 6x9 in.; illustrated.

FUNDAMENTALS OF A COST SYSTEM FOR MANUFACTURERS—Washington, D. C.: Federal Trade Commission. Paper; 6x9 in.; pp. 31.

HANDBOOK FOR HIGHWAY ENGINEERS: Containing Information Ordinarily Used in the Design and Construction of Roads Warranting an Expenditure of $5,000 to $30,000 per Mile. Part I, Principles of Design. Part II, Practice of Design and Construction—By Wilson G. Harger, C. E., First Assistant Engineer, New York State Department of Highways, and Edmund A. Bonney, Supervising Engineer, New York State Department of Highways. Second edition entirely revised and enlarged. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C. Leather; 4x7 in.; pp. 609; illustrated. $3 net.

HOW TO BUILD UP FURNACE EFFICIENCY: A Handbook of Fuel Economy—By Joseph W. Hays, author of "The Chemistry of Combustion," "Combustion and Smokeless Furnaces," etc. Tenth edition, revised and enlarged. Rogers Park, Chicago: Jos. W. Hays. Paper; 5x8 in.; pp. 154; $1.

HYDRAULIC FLOW REVIEWED: A Book of Reference of Standard Experiments on Pipes, Channels, Notches, Weirs and Circular Orifices, Together with New Formulas relating Thereto—By Alfred A. Barnes, A. C. G. I. New York: Spon & Chamberlain. Cloth; 6x10 in.; pp. 158; Illustrated with frontispiece and 2 folding plates. $4.50.

THE LEGACY OF THE EXPOSITION—Interpretation of the Intellectual and Moral Heritage left to Mankind by the World Celebration at San Francisco in 1915. San Francisco: The Panama-Pacific International Exposition. Cardboard; 7x10 in.; pp. 187.

Numerous short laudatory letters, alphabetically arranged, the publication of which suggests that the authorities were at their wits' end to know what to do with surplus funds or else were quite carried away with so many songs of praise.

THE MELTING OF SNOW—By Robert E. Horton. (Reprinted from Monthly Weather Review, December, 1915, 43: 599-605.) Washington, D. C.: United States Department of Agriculture, Weather Bureau. Paper; 9x12 in.; pp. 7; illustrated.

PROCEEDINGS OF THE THIRTEENTH ANNUAL CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION Held at Pittsburgh, Penn., Feb. 28 to Mar. 3, 1916, together with Reports of the Executive Secretary and Treasurer Presented at the Annual Meeting, Feb. 4, 1916; List of Members, etc., New York: American Road Builders' Association. Paper; 6x9 in.; pp. 263.

PUBLIC SERVICE COMMISSION, SECOND DISTRICT, STATE OF NEW YORK—Annual Report for the Year Ended Dec. 31, 1914. Vol. III. Albany, N. Y. Cloth; 10x12 in.; pp. 325.

PUBLIC WORKS DEPARTMENT, MADRAS PRESIDENCY—Administration Report for the Year 1914-1915. Part II. Irrigation. Madras: Superintendent, Government Press. Cardboard; 8x13 in.; pp. 270; diagrams. 5s.

QUESTIONS AND ANSWERS RELATING TO MODERN AUTOMOBILE DESIGN, CONSTRUCTION, DRIVING AND REPAIR: A Practical Treatise Consisting of Thirty-Nine Lessons in the Form of Questions and Answers Written with Special Reference to the Requirements of the Non-technical Reader Desiring Easily Understood Explanatory Matter Relating to All Branches of Automobiling—By Victor W. Page, M. E. New York: The Norman W. Henley Publishing Co. Cloth; 5x8 in.; pp. 701; 387 illustrations. $1.50.

Includes all latest 1916 developments, with complete discussion of electric starting and lighting systems.

THE REMOVAL OF IRON FROM MUNICIPAL WATER SUPPLIES—By James W. Schwab. Engineering Bulletin No. 7. Bulletin No. 1, Division of State Chemical Research. Lawrence, Kan.: University of Kansas. Paper; 6x9 in.; pp. 41; illustrated.

THE SLIDE RULE: A Practical Manual—By Charles N. Pickworth, editor of "The Mechanical World"; author of "Logarithms for Beginners." Fourteenth edition. New York: D. Van Nostrand Co. Linen; 5x7 in.; pp. 124; illustrated; $1 net.

STRAIGHT AMERICA: A Call to National Service — By Frances A. Kellor. New York: The Macmillan Co. Cardboard; 4x7 in.; pp. 193.

STRENGTH AND OTHER PROPERTIES OF CONCRETES AS AFFECTED BY MATERIALS AND METHODS OF PREPARATION—By R. J. Wig, Engineer Physicist, G. M. Williams, Assistant Engineer Physicist, and E. R. Gates, Assistant Physicist. Technologic Papers of the Bureau of Standards, No. 58. Washington, D. C. Paper; 7x10 in.; pp. 172; illustrated.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA—By Charles Proteus Steinmetz, A. M., Ph. D. Fifth edition thoroughly revised and entirely reset. New York: McGraw-Hill Book Co., Inc. London: Hill Publishing Co., Ltd., 6 and 8 Bouverie St., E. C. Cloth; 6x10 in.; pp. 480; illustrated. $4 net.

WATER RESOURCES OF SAN DIEGO COUNTY—Report of the Water Committee to the Board of Directors of the San Diego Chamber of Commerce, May 15, 1916 (C. S. Alverson, Hydraulic Engineer). Paper; 4x6 in.; pp. 46.

Field and Office

Demolishing Old Steel Bridge and Handling Heavy Girders

By Smith O. Steere*

The demolition of an old three-span 400-ft. lenticular truss bridge across the Allegheny River at Main St. in Salamanca, N. Y., was accomplished by the Owego Bridge Co., of Owego, N. Y., as follows: Falsework of 8x8-in. hemlock timber and swaybracing was erected under each of the three spans of the old bridge. Then, beginning at the south bank, each truss was slightly jacked up and blocked so that it rested on the falsework. The procedure then consisted in disconnecting the members of the truss by hand-cutting of the rivets, commencing with the top swaybracing, the top chord members and the diagonal and vertical members of the trusses, and lowering them one by one with a stiff-leg derrick to waiting trucks. This was continued until all of the

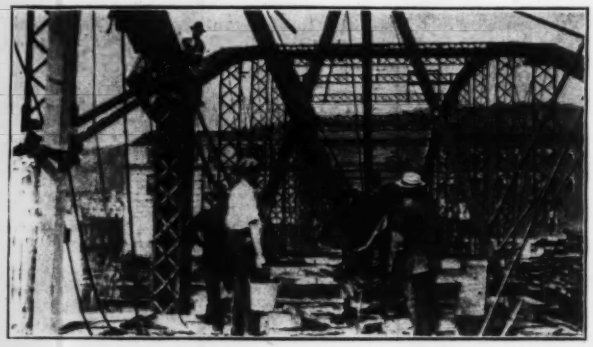


FIG. 1. HAND DERRICK TAKING DOWN MEMBERS OF OLD TRUSSES, SALAMANCA BRIDGE

superstructure above the floor was removed. The flooring, old car tracks, stringers, floor-beams and lower-chord members were then removed, beginning at the north shore span and proceeding toward the storage piles back from the south shore. It required 22 working days to demolish the old bridge, at an approximate cost of $3 per lin.ft. of bridge.

The three stone river piers of the old bridge were razed to low-water mark by drilling and breaking the stone into man-size pieces. A portion of these stones was used in the concrete, while the rest was wasted at the upstream end and along the sides of the piers.

The new bridge is a plate-girder cantilever bridge of five spans varying from 74 to 92 ft. long. The large cantilever girders, 116 ft. long and weighing 26 tons, were delivered at the railroad station ½ mi. south of the bridge on three flat-cars, one middle spacing car, and two end supporting cars. The girders, mounted on triangular shipping frames, were raised from the cars and then lowered to greased rails resting on timber blocking. Jacks placed near each end of the girders forced them sidewise over the rails to additional timber blocking, whence they were lowered to the heavy beam trucks. Mounted on these beam trucks, they were snubbed to the bridge site and out over falsework, where again they were blocked up,

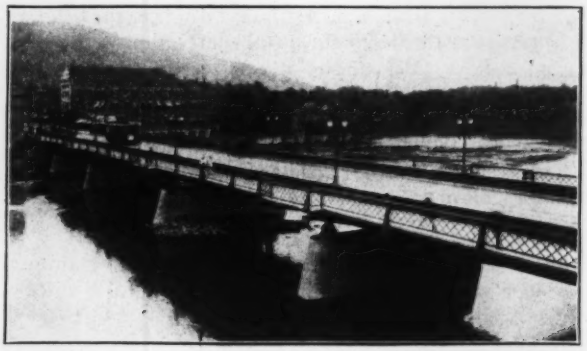


FIG. 2. NEW PLATE-GIRDER CANTILEVER BRIDGE

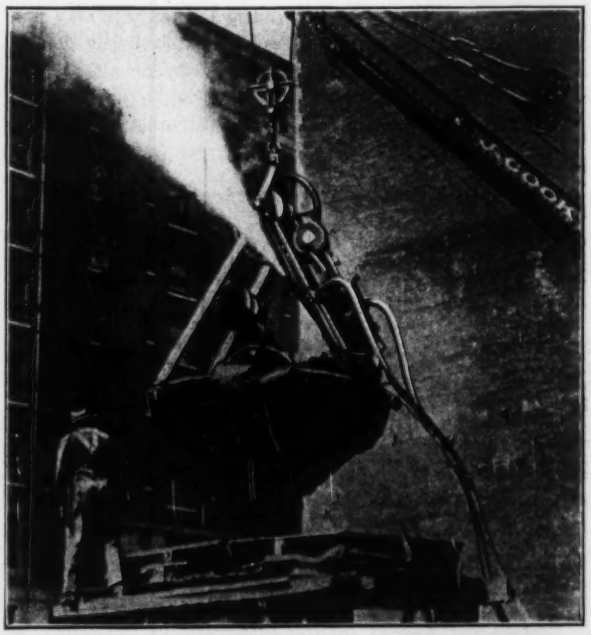
the beam trucks removed, and then lowered and placed in their respective positions over the piers.

When the girders for a unit of the bridge were placed in position, a stiff-leg derrick swung the floor beams and stringers and other light parts to their proper places.

*Assistant Engineer, New York Highway Department; Montela, Ulster County, N. Y.

Clamshell Bucket Closed By Steam Engine

Foundations of buildings in Portland, Ore., are in general upon a close clay soil that underlies the city to a great depth. This material is very difficult to handle with ordinary buckets, and where the area excavated is too small to warrant installing a revolving



A CLAMSHELL WITH ATTACHED STEAM ENGINE

shovel the practice has been to load skips by hand. The skips are hoisted from the pit by a revolving derrick and dumped onto a portable trap platform from which the wagons are loaded.

C. J. Cook, of the C. J. Cook Co.—a contractor who handles much of the basement excavation work in Portland—has recently devised for this work a clamshell bucket closed by a small two-cylinder steam engine, which gives sufficient digging power to handle this material very well. The bucket is a reconstructed Williams clamshell, and the engine is geared to a pair of differential drums. Steam is supplied by hose from the derrick boiler, and the control is by valves at the hand of the derrick engineer.

A Rural Highway Bridge of Strange Design

By Henry Blood*

The bridge shown in the accompanying sketch crosses the south fork of the Santian River at Cascadia, Ore., a summer resort on the edge of the Cascade Range. It is on a county road, and is used by practically all vehicles passing up or down the valley. Quite a number of automobile parties, with or without camping outfits, use it. As the road is in poor condition, the loads are limited, but still may be considerable. The bridge was built in 1915.

There are several unusual features. All the larger timbers have been hewn out, as they were too large for the local sawmill. The bottom chords are single sticks 12x14 in. by 120 ft. long without splices. The top chords are also without splices. No metal was used except the vertical rods, plate washers for the rods, and nails. Plenty of good Douglas fir timber could be obtained within a short distance; iron and steel had to be hauled 32 mi. There are no portals, swaybracing or top laterals, but the gable roof and sides help to stiffen.

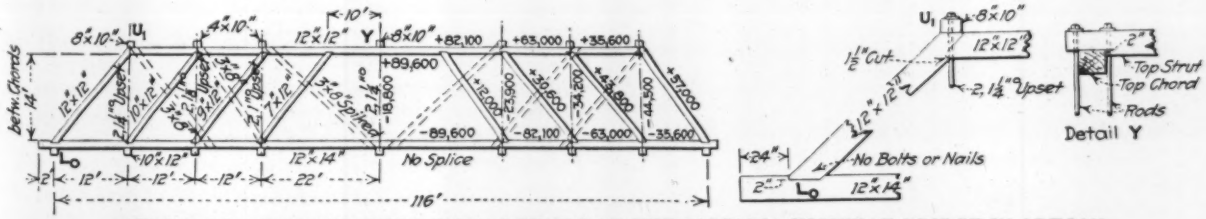
The most interesting point is the absence of web bracing in the central portion of the bridge, while the center floor-beam, carrying 22 ft. of floor, is hung from the top chord on a 20-ft. span. The rods are not well proportioned to take the increasing shear toward the ends, but if the two 1¼-in. upset rods at the center should ever be loaded to 15,000 lb. per sq.in., what would happen to the bridge? Allowing 20% for continuous action of the chord, and neglecting the weakening effect of the 2-in. notches for diagonals, the extreme fiber stress due to bending would be 6,100 lb. per sq.in. The average modulus of rupture of Douglas fir at breaking is 5,000 to 5,400 lb. per sq.in. The bottom chord cannot help, as the floor-beam is suspended below it.

The dead load is about 750 lb. per lin.ft. If the live-load is taken at 60 lb. per sq.ft., or 960 lb. per lin.ft. of bridge, the load on the center rods is 18,800 lb., and the stresses are those given in the sketch. The direct stress in the center panel of the top chord is 622 lb. per sq.in. and the compression due to bending—allowing 20% for continuity as before—is 3,133 lb. per sq. in., making a maximum compressive stress of 3,755 lb. per sq.in. The usual working stress is 1,200 to 1,600 lb., reduced by a column formula.

The effect of moving loads is not provided for: The 3x8 counters are merely spiked to the outside of the chords with two or three nails at each end.

Not far from this bridge there is a similar one of 60-ft. span. The construction is the same, but the center floor-beam carries only 16 ft. of floor, and the distance between the upper ends of diagonals is only 8 ft. The top chords are 12x12s.

Plans for both bridges probably were prepared by the county bridge carpenter. The workmanship was good, but there was a little oversight in design.



STRESS DIAGRAM AND THE DESIGN DETAILS OF THE CASCADIA HIGHWAY BRIDGE IN OREGON

Floor-beams, 10x12-in.; stringers, 7 lines 3x12-in.; 3-in. floor planks; no portals or swaybracing; bottom laterals about 6-in. diameter spiked; diagonals cut in chords about 2 in.; dead load = 750 lb. per lin.ft.; live-load = 960 lb. per lin.ft.; 116-ft. span; 16-ft. roadway; trusses 15 ft. deep c. to c.; covered sides and roof

New Lubrication System for Construction Machinery*

By S. E. Lawrence†

The lubrication of machinery used on construction work is an unsatisfactory process at best. The varied types and kinds of machines, the changing conditions of work, the exposure of parts to weather, and the personal equation, all combine to make proper lubrication a more serious problem than most persons realize. Here is discussed only the steam, or cylinder and valve, side of this question and the special system devised for the construction machinery employed chiefly on Ohio River Lock and Dam No. 43, which is being built by hired labor under the direction of the Louisville office, Maj. J. C. Oakes in charge.

The chief difficulties were (1) securing a proper lubricant (which means principally a lubricant of proper viscosity at the temperature at which it is to work), (2) the delivery of lubricant, free from foreign matter and at a reasonable price, to the engine, (3) a lubricator that will properly admit it to the steam space, (4) intelligent use of lubricant by the operator.

On most construction work each machine has its oil cans to start with but as a job progresses, and with all

*Engineer, Bureau of Bridges, Portland, Ore.

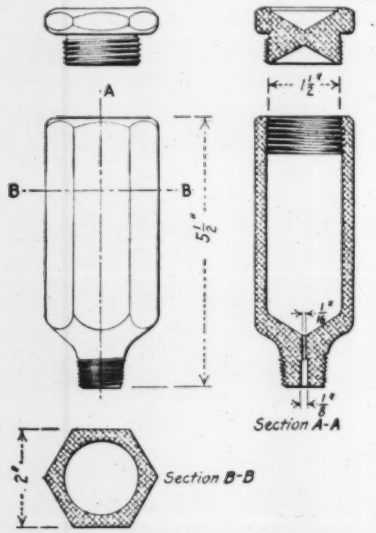
*From notes in "Professional Memoirs, Corps of Engineers, U. S. Army, and Engineer Department at Large," August, 1916.

†Junior Mechanical Engineer, U. S. Engineer Department at Large; Superintendent of Machinery and Floating Plant, Lock and Dam 43, Ohio River.

the care that is exercised, it is not many weeks before tomato cans are in evidence in place of properly protected oil containers.

Too often the filling of the lubricator is left to a fireman or oiler who is not very familiar with the inside workings and shortcomings of a slightly out-of-repair lubricator. It is safe to say that 50% of the enginemen employed on construction work are not familiar with the principles and repair of the single- and double-connection sight-feed lubricators commonly used; a still smaller percentage are familiar with mechanically operated lubricators and oil pumps. When oil is permitted to get dirty and clog the small valves damage is usually done to the engine cylinder and rings before the difficulty is remedied.

When an engine exhausts directly into the air, as most construction engines do, much of the lubricating



DAVIS LUBRICATOR FOR CONSTRUCTION MACHINERY

oil, as generally used, is blown through the cylinder and valve ports. Lubricating oils, unless of an expensive grade with a high viscosity, usually become "thin" under ordinary steam temperatures, and if a regular supply is not forthcoming dry rings result; also, practically no lubrication is afforded the piston-rod packing because of the strong exhaust scavenging the cylinder of its oil surplus.

Through intermittent use, in a hoisting engine, pile-driver engine, steam pile-hammer, mixer engine, crane, etc., condensation is apt to take place even with the best of drainage; rough usage and a quick opening of the throttle is the rule and not the exception. These factors determine the conditions that have to be accepted and a system must be devised to meet them. The ideal lubricant must be of such a nature that it will eliminate friction, as far as possible. It must be of a consistency that will perform this function at the temperature of the cylinder. It must have sufficient adhesion to the rings, cylinder walls and valves so as to be of service for more than one revolution of the engine; if it can go farther and serve other desirable ends it adds much to its desirability. Such other purposes may be the lubrication of piston rod and piston-rod packing, protection of valve, valve seat and steam spaces from rust, when the engine is temporarily out of commission, the filling of pits or uneven places in cylinders that have been neglected, increasing the compression by filling space between worn rings and cylinder walls, etc.

When an engine is working at varying speeds there is need of lubrication in the cylinder and valves directly in proportion to the number of its revolutions—a ratio that is not maintained by the regular feed of the ordinary lubricator, which admits so many drops per minute irrespective of the changing of the revolutions of the engines.

After a practical study of the difficulties to be overcome a system of steam lubrication for the machinery used on the construction of Lock and Dam No. 43, Ohio River, was worked out.

The container or lubricator devised is a simple valveless cylinder, as shown in the accompanying sketch, consisting of a short section of hexagon bar brass or Muntz metal, turned down and threaded on the outside of the lower end. The top is threaded on the inside and a cap of the same material turned to screw tightly into it. A small hole is drilled through the bottom of the cup. The size of this orifice was varied and experimented with, for the various engines on which it was to be used, until a satisfactory feed was obtained. This container is screwed directly into the steam pipe, steam chest, or, in some cases, directly into the head of the cylinder, the lubricant placed in it and cap securely screwed down, the regular outside shape making this a simple matter for an ordinary wrench.

The lubricant used consists of a mixture of flake graphite, cylinder oil and sufficient wax to form a mass of a consistency that can be easily handled and molded into cartridges which will retain their form under all ordinary atmospheric temperatures. By experiment, it was found that a cartridge of a certain diameter and length would supply a certain engine for a stated length of time and the amount placed in the lubricator was gaged accordingly. After the cartridge was introduced, no further attention was necessary until the determined time had expired—a day's run usually.

It was found that the change of pressure in the steam space, induced by the events of the stroke, regulated the feed from the lubricator automatically. The more the r.p.m. the faster the feed, and when the engine stopped the feed stopped; when the steam was again turned on the feeding was again resumed. The heat of the steam reduced the lubricant to a fluid state, which permitted it to pass through the orifice in pulsations. It would not run out without the assistance of unbalanced steam pressure, however.

The cartridges are molded in an improvised wooden mold and cut into different lengths, each one representing 8-hr. run for some particular engine, wrapped in paper and given to the engineman, a week's supply at a time. The simplicity of the lubricator, with its valveless automatic operation, eliminated the personal factor to a great extent and earned for it the name, "The Davis Fool-Proof Valveless," by which it is locally known and under which name a patent is now pending, G. M. Davis being the man largely responsible for perfecting the device.

After a period of use, the engines that had been equipped were examined and everything was found in excellent condition. The cylinder walls, valves and steam

chests were found coated with a thin layer of graphite and the piston packing was shown to be impregnated with it. It was also found that the engine could be operated for from two to three days without additional lubricant being required.

A lubricator of sufficient size to contain a day's run for an 8x8-in. engine was produced for approximately 75c. and replaced a 1-pint double-connection sight-feed lubricator of standard make costing from $7 up. The lubricant for an 8-hr. run cost 2½c. and did the work of 1 qt. of cylinder oil which costs 16 to 55c. per gal. and more. Taken at the lowest price paid there was a saving of 60% over the former costs of lubrication. The saving in packing was hard to estimate, but it is safe to say that the packing lasted in most cases from one-third to one-half longer in the hardest worked engines and in some special cases much longer.

In one favorable instance—on a vertical engine operating the floating machine shop, one of the first engines on which the scheme was tried—the original fibrous piston-rod packing is still in use after two years, part of this time operating 16 hr. a day. The accumulation of graphite in the packing has necessitated slacking off instead of tightening up the piston-rod gland.

The following different kinds and types of machines were fitted with this system: Steam pile-hammers, pile-driver and derrick engines, horizontal reciprocating engines (sizes up to 16x22 in.), vertical shop engines, locomotive cranes, generator engines (650 r.p.m.), locomotives, and also on steam pumps of various sizes.

During the past winter (1915-1916), when the machinery of the Lock and Dam No. 43, Ohio River, plant was overhauled, it was not found necessary to rebore a single cylinder or replace a single broken ring or piston rod on any of the engines which had been so equipped. One cylinder left exposed to air for two months showed no sign of rust. There were, of course, no repairs necessary to lubricators, there being no parts or valves subject to deterioration.

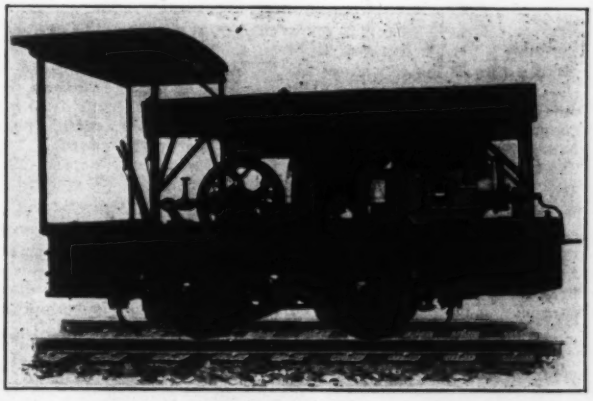
Contractors' Gasoline Dinkey with Friction Drive

A type of gasoline locomotive now in use on construction work and industrial service (and also in mines) has as one of its main features a friction drive for variable-speed transmission. In the locomotive shown in the accompanying view, the four-cylinder vertical engine at the right drives the face wheel or friction disk at the left of the tank. Against the face of this disk runs the rim of the wheel on the transverse shaft, this wheel being fitted with a fiber ring. Speed is varied by shifting this wheel laterally along its shaft so as to ride against the higher or lower speed portions of the disk. A sprocket chain from this shaft drives a countershaft with chain drives to both axles.

The frame is composed of four heavy castings, giving weight and stability. Pockets in the end castings provide for convenient coupling to cars of different heights. The 3-ton locomotive illustrated has an engine of 23 hp. (at 1,000 r.p.m.) driving a 23-in. friction disk and 22-in. fiber-faced wheel. It is mounted on four 18-in. steel wheels, with a wheelbase of 39 in. All bearings are fitted with flexible roller bearings, except that double-row ball bearings are used for the shaft of the friction disk. The machine has a maximum speed of about 10 mi. per hr, and a drawbar pull of 1,200 lb. at 5 mi. per hr. It carries 20 gal. of gasoline and 50 gal. of water and consumes 5 to 6 gal. of gasoline in a 10-hr. working day. The 6-ton machine has a 50-hp. engine giving the same maximum speed, but a drawbar pull of 2,400 lb. at 5 mi. per hr.

The engines are built for tracks of 24- to 56½-in. gage and with or without a cab, according to the character of the service which they are to perform. They are built by the J. D. Fate Co., of Plymouth, Ohio., which has recently introduced a number of improvements upon the earlier design. In service the mechanism is protected by curtains, but these are rolled up in the view in order to show the machinery.

These engines have been used on several large construction jobs, including the Louisville & Portland canal lock at Louisville, Ky., Ohio River dam No. 48, New York State highway work, the Boston drydock and the Halifax harbor works. There are nine of them at work on the Winnipeg aqueduct, where they haul concrete in trains of three or four steel hopper cars of ¾-yd. capacity. The length of haul is about ½ mi. The records of the United States Engineer Office for work done on Ohio River dam No. 48 (by the Ohio River Contract Co.) shower that from Aug. 6 to Oct. 23, 1915, with two of these engines 9,810 batches of concrete (9,136 yd.) were placed in 269 working hours, or at the rate of 36.5 batches per hour. The most rapid work was 46 batches placed in 1 hr. The total mileage for the two engines was 1,667 mi., with a haul ranging from



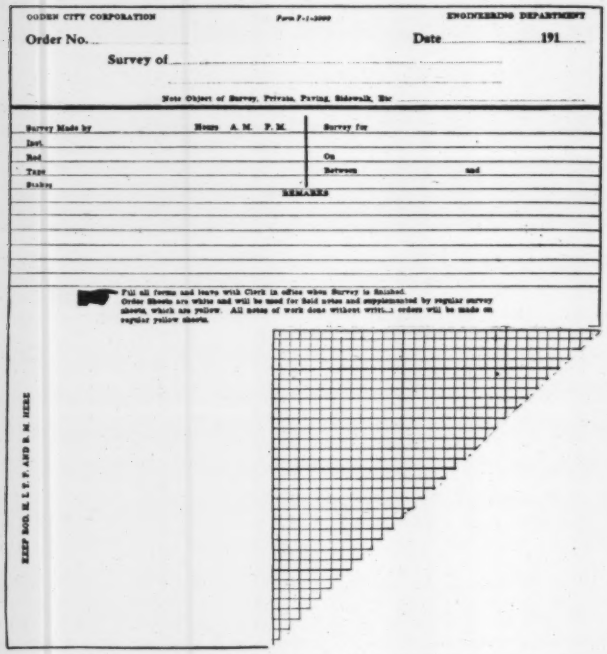
GASOLINE LOCOMOTIVE FOR CONSTRUCTION WORK AND INDUSTRIAL RAILWAYS

215 to 790 ft. The labor cost was 37½c. per hr. as compared with $1.40 per hr. for horse haulage.

On the New York State highway between Syracuse and Bridgeport two of the 3-ton locomotives of 24-ton gage were used by Phelan & Sullivan, the contractors, in 1915. Each engine would take a train of nine 1½-yd. cars of gravel and make 10 trips per day, with a haul of 2¼ mi., and could take 12 cars when necessary. The cost for wages, gasoline and oil was about 5c. per yd. On other work the engines serve steam shovels handling cars of excavated material.

NOTES

Loose-Leaf Notes for Surveys on blank forms of an unusual type are employed by the city engineering department of Ogden, Utah. A reproduction of one of these forms is shown in reduced scale; the full size is 8x9 in.—on yellow paper. The sheet is folded in the middle and laid between board covers provided for that purpose. An elastic band over the


OGDEN CITY CORPORATION — ENGINEERING DEPARTMENT

Order No. ... Date ... 191...

Survey of ...

Note Object of Survey, Private, Paving, Sidewalk, Etc ...

Survey Made by ... Hours A. M. P. M. | Survey for ...

Inst. ...

Rod ... On ...

Tape ... Between ... and ...

Stakes ...

REMARKS

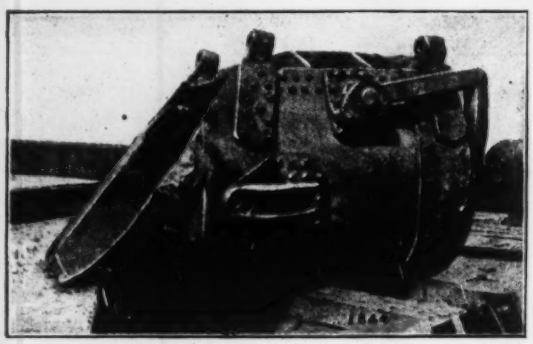
Fill all forms and leave with Clerk in office when Survey is finished.
Order Sheets are white and will be used for field notes and supplemented by regular survey sheets, which are yellow. All notes of work done without writt...l orders will be made on regular yellow sheets.

KEEP BOOK H. L. P. AND B. M. HERE

LOOSE-LEAF NOTE FORM FOR OGDEN CITY SURVEYS
One corner turned back to show ruling on reverse side of sheet

middle fold holds the sheet in the binder. The front page of the folded sheet is for a brief description of the survey, by whom made, date, etc. The two facing pages form a single sheet 8x9 in. of square-ruled cross-section paper, each square being ⅛ in. on a side. This of course is for the sketch. The back page of the folded sheet is for the survey notes. The city engineer of Ogden is Joseph M. Tracy.

A Dredge Dipper Was Repaired by Welding and the process was described by T. E. Rosselle in "Reactions." The large dipper of the "Grampus"—operating in 30 ft. of water at the ocean ferry and steamship docks at Key West—was broken in several places while at work. The bottom on which the dredge is working is of coral formation that is very hard

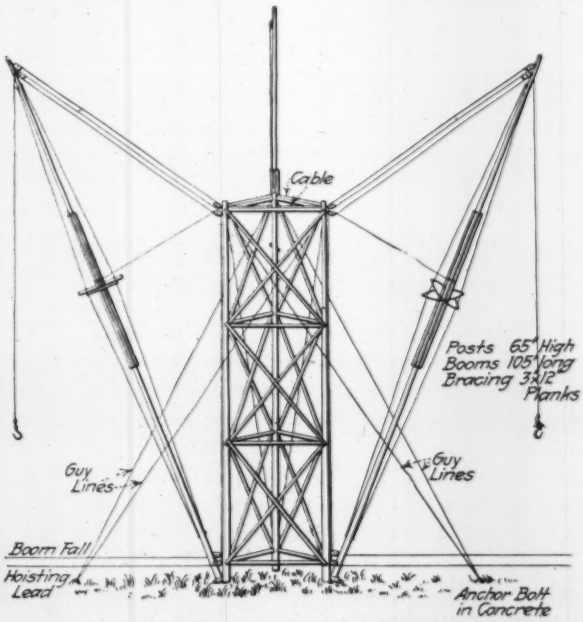


DIPPER OF DREDGE "GRAMPUS," REPAIRED BY WELDING

on the dipper. The break occurred across the entire mouthpiece, which is 2 in. thick. The spare dipper was unavailable at the time, so the broken dipper had to be repaired immediately. The welding was accomplished successfully with about 75 lb. of "Railroad Thermit." The dipper is shown in the view. Two other welds were made on this dipper, using about 100 lb. of Thermit each, the breaks being about 16 in long. Oxyacetylene was used for cutting out the parts to be welded and also for cutting off the metal left in the pouring gates.

An Odd Laboratory Explosion recently occurred at the University of Illinois and was described in the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society. A pestle and mortar were used for grinding about 15 lb. of chlorate of potash, and after the grinding was completed the pestle and mortar were thoroughly washed and dried. A few days later the same outfit was used for crushing pumice stone, and the work had barely started when an explosion occurred and the mortar and pestle were broken to pieces. The room was filled with sulphur fumes, and fine particles of sulphur were found upon the floor. The presence of the sulphur was a mystery until it was found upon examination that the joint between the handle and body of the pestle was sealed with sulphur. It is believed that a small quantity of chlorate of potash found its way into a crevice in the sulphur seal, and that it combined with the sulphur to cause an explosion when the pestle was jarred in the process of grinding the pumice. The accident led to a thorough examination of other pestles of the same type in the laboratory, and it was found that each of them contained sulphur in amounts varying from one-third to three-quarters of an ounce. Chlorate of potash is rich in oxygen, and for that reason must be handled with great care.

Erecting the Canacao Radio Towers—The first 90 ft. of the Canacao Radio Towers, recently erected in the Philippine Islands, was placed by three 105-ft. booms swung from a centrally located falsework tower shown in the sketch. These booms were operated by hoisting engines located on platforms directly behind the three tower footings. The booms were rigged as shown. A 40-ft. length of 12x12-in. was butt-spliced to a 65-ft. Oregon pine pile with four 40-ft. 8x8's bolted across the joints. After one of the booms had broken in two, a ¾-in. cable truss was arranged. When the tower was 90 ft. high the falsework was dismantled and moved 1,000 ft. north to the site of the second tower, and a short boom was then mounted



THREE-BOOM TOWER THAT ERECTED FIRST 90 FT. OF CANACAO RADIO TOWERS IN PHILIPPINE ISLANDS

on each leg and swung from the main column. With this and a light pair of shearlegs it was possible to place all the steel up to the 150-ft. elevation. This method of erection, described by P. E. M. Wheat, Assistant Engineer, Bridge Division, Bureau of Public Works, Manila, P. I., in the "Quarterly Bulletin," is similar to the method employed in erecting the Darien towers. Identical stations are being erected at San Diego, Calif., and at Pearl Harbor, Hawaii. The towers are 600 ft. high. The Canacao towers and station should be finished by Jan. 1, 1917.

Editorials

Public Interest Paramount in Railway Strikes

A member of the engineering staff of a railway in the South (Robert T. Frazier, Nashville, Chattanooga & St. Louis Railway) is engaged in an unusual piece of work—for an engineer. He is giving publicity to the idea that the threatened railway strike is being agitated for the benefit of only 16% of railway employees, and that the strike as it has been planned would injure the 84% out of measure. He therefore pleads for action that would put differences that cause or threaten strikes in the hands of the Interstate Commerce Commission or some other competent jurisdiction.

The case for powerful measures to prevent railway strikes is broader and stronger than the 84 to 16 percentages urged by Mr. Frazier. It is rather a 99 to 1 percentage, or nearly the whole population of the country against a comparatively few railway owners and their employees. This the public itself has been slow to realize and slower yet to make of practical effect. But a change is already apparent. It was largely due to a dawning recognition of its interest and its power on the part of the public that the New York street railway strike came to so speedy an end a few days ago. The same underlying cause explains the balanced deliberations of last week over the threatened steam railway strike.

If the railway officials and their employees cannot agree on fair wages and working conditions without stopping or even seriously threatening to stop business and cause food shortages and other disaster everywhere, then the public must find a way by which adequate railway service will be put first and differences between employers and employed be settled afterward.

More Funds To Study Rainfall Are Needed at Once

Not a drop of rainfall was reported by the observers of the Weather Bureau in all of West Virginia on the day of the Coal River "cloudburst" and flood. There were no observing stations in the area covered by the storm. A serious error will therefore vitiate our records of flood-storms and precipitation. And, be it remembered, it is from the figures of these records that we design our flood-protection works and spillways.

We must have better records, safer records. The security of all dams and flood works depends on the accuracy of the recorded rainfall figures.

Errors such as that in West Virginia have probably occurred many times. There are now in the records various local storms of great intensity and small areal extent that were observed only by chance. Thus, in one instance in Ohio a storm of unprecedented intensity—vitally important in relation to the expenditure of millions of dollars for flood works—was observed only because it happened to center directly over an observing station. But stations are many miles apart, often many hundreds of miles, and the happenings between stations remain unknown to the records. Well-founded suspicions have been entertained heretofore that many important storms went unobserved and unrecorded. These suspicions become practical certainties in the light of the present case.

A great increase in number of rainfall stations is needed, and needed at once. The Weather Bureau should be put in possession of sufficient funds by the present Congress. Efforts to secure such increase have been made, but with only insignificant success. The time has now come when the question must be handled in radical fashion. Further delay in laying a broad foundation of definite knowledge on which to erect the costly structure of future waterway and flood works jeopardizes lives and dollars.

The Work at Quebec

New standards in bridge work are established by the erection of the Quebec Bridge. Methods of micrometric precision were applied, and, broadly viewed, the crude processes of steel erection were placed on a scientific basis. The field problems have been handled with the same boldness in scrapping traditions, and the same ingenuity, that marked the design of the epoch making K-truss project.

The methods developed and applied are new and full of bold pioneer spirit in almost every part. Under these conditions it is hard to pick out one element as of outstanding importance. Yet with respect to the general problems of bridge engineering first place must be given to that part of the work by which the bottom-chord secondaries were eliminated—down to a small residual, at least.

The idea underlying this operation is not new, but prior attempts to turn it into reality have been of elementary character and of doubtful efficacy. For Quebec a system of machine-like perfection of action was employed, and definite results produced. Through this success the secondary-stress problem is advanced into a wholly new stage.

In the operation referred to, a strong, stable platform was provided out ahead of the bridge already erected; the chord member about to be erected was laid on this platform, its rear end rigidly connected to the preceding chord section, and its forward end then bent by hydraulic jacks sufficiently to make connection with its meeting web members—an amount so adjusted in the prior construction that when the bridge is finished the chord will be under direct endwise compression, without distortion by bending.

It is useful to recall the action which produces these secondary stresses, stresses arising from the deflection of the bridge rather than primarily from the load.

Note first that the bridge truss is made up of triangles; then notice that the position of any particular triangle with respect to the whole truss is such that at least one of its three bars is in tension, and at least one in compres-

sion, when the bridge is loaded. Of course the compressed bars shorten, while the others stretch, when the load is applied, and thus the ratios of the sides of the triangle change, that is the triangle changes its shape, and its angles change slightly. That is, the angles change if the three bars are joined to each other by easy-moving hinges. But the members of a bridge truss are not ordinarily so joined; instead, they are connected either by stiff-fitted pin joints or by rigid riveting, and the angles between them cannot change. The result is that the three bars of the triangle, in trying to change their angles, become bent.

This action takes place whenever a load comes on the bridge. Each bar or member then bends slightly, besides being compressed or stretched by its direct axial stress; it returns when the load goes off the bridge. The bending of the bar means stress—unnecessary stress—superadded to the regular axial stress which it is the particular duty of that bar to resist. One of two things is then true: Either the bending stress, the "secondary stress," encroaches on the safety margin of the bridge, or else we spend extra money in providing additional strength in every member. The former was the universal case until recent years, and is still the common case. The most advanced practice of today is to calculate the amount of secondary stress, and provide strength to resist it.

Bending of the members, secondary stress, is thus an inevitable concomitant of deflection. We have to note that secondary stress arises when a bridge deflects under its own weight. It is erected, let us say, in horizontal and unstressed position, being supported on falsework; when the wedges are knocked out it deflects, and its members experience secondary stresses. Or, it is erected by cantilevering. The triangle set in place at the forward end is practically free from stress at the time it is joined up, whereas later it is put under heavy stress by the weight of that part of the bridge built outward from it; and this stress means bending.

In very large bridges the dead-load stress is much greater than the live-load stress, and correspondingly the secondary stress due to deflection under the weight of the bridge itself is much more serious a factor than the live-load secondary. In fact, the live-load bending may be neglected, if only the dead-load bending can be taken care of.

By bending a bridge member while erecting it—springing it into place so bent that it will be just straightened by the oppositely acting bending which occurs under full dead-load, secondary stress is eliminated, so far as dead-load is concerned. This theoretical possibility has been realized partially in the past by connecting a member rigidly at its rear end when erecting it and then springing its forward end to place for connecting the triangle by using rope tackle. In place of this crude procedure the Quebec Bridge erectors substituted a beautiful mechanical system, which so far as the bottom chord is concerned gives full control of the bending and makes possible the measurement of both the bending force and the deflection.

The most spectacular operation of the Quebec Bridge enterprise remains. The suspended span must be hoisted from the river level 150 ft. up into place. This operation involves untried elements in its mechanism, and will place a crown of distinction on the heads that direct its successful accomplishment. In its relation to the engineering problems of bridge construction, however, it can hardly take higher place than the work already done in erecting the two great cantilevers as they are pictured in panoramic view on another page. An authoritative detail description of the procedure, prepared for *Engineering News* and published in this issue, will enable the reader to appreciate the notable character of the performance.

Monthly Guide to Engineering Books and Pamphlets

Engineers like doctors may be divided into two classes: Those who keep abreast of their profession by securing and reading the best literature of the day and those who are "too busy to read" or who let themselves think they are too poor to buy books and periodicals.

The busier the engineer or the leaner his pocketbook—in fact or fancy—the greater the need that he should know just what is the newest and best in engineering literature. To this end for nearly fourteen years no pains have been spared by *Engineering News* to announce immediately and describe and estimate as promptly as is consistent with careful weighing all new technical books that promise to be of interest and value to its readers—or indeed that have no such promise and therefore should be avoided. As a convenience to all concerned these announcements are made in the third issue of each month, thereby passing a goodly number of publications in review and simplifying the task of those who wish to order the books they must buy or to send the proper person a request for some of the many good publications that may be had for the asking.

The foregoing remarks have been prompted by the number and variety of volumes noted in the "Engineering Literature" section of this issue. To those who have passed it by as beyond—we hope none regard it as beneath—their interest we make bold to ask that they turn back and glance over the 35 reviews and notes and the 20 acknowledgments of books and pamphlets fresh from the press—some of which will be reviewed in later issues.

What Engineers Can Do To Stop Infantile Paralysis

Knowledge of the way typhoid fever, cholera, yellow fever, and malaria are spread from person to person has given engineers opportunities which they have embraced with marked success. Who knows but what before the present outbreak of infantile paralysis is over the mystery as to how the disease is spread from person to person will have been cleared away and there will stand revealed other points of attack for engineers? It does not seem likely that such will be the case but it is possible.

Meanwhile the large number of engineers who have learned the principles of sanitary science and public health, even if no more than to have their minds cleared of some of the silly traditions of an ignorant past, can perform a useful part in their several communities. They can seize upon the present awakening to a single health menace and press home the importance of securing a competent local health-protective agency that will guard against not merely infantile paralysis but all other communicable diseases as well.

Policemen with shotguns at city borders are not going to kill or scare off disease germs, as so many communities backward in real health-protective agencies seem to think. A trained health officer at the center of the town, with as many trained assistants as the size of the town and the conditions of the moment may require, is the only real safeguard. The sanitary engineer can drive home this and other simple but fundamental principles of public health. And until the scanty supply of trained health officers is increased a thousandfold, the better trained and more experienced sanitary engineers of the country should be eagerly sought by municipalities to equip the ranks of health officers.

The utter inadequateness of the health service of scores of cities and towns shown during the last few weeks should create such a demand for trained health officers as would fill our schools of public health and our well-conceived courses in sanitary engineering to overflowing. It should also serve to remove the suicidal provision of the health laws of New York and some other states, prohibiting the employment of other than physicians as health officers.

What Does Night Work Cost Compared with Day?

What percentage of extra cost is involved where construction work is carried on with a night shift? In view of the frequency with which night forces are worked it is astonishing how little dependable data are available as to the comparative cost of the two classes of work.

Under ordinary conditions of course day work is more efficient than night work. Other factors sometimes reverse this condition. In track work on a street railway for example, a night gang can accomplish more than the day force, which would be frequently interrupted by the passage of cars. In hot climates or in summer, the men can work harder at night as they are not exposed to the sun. Ordinarily, however, daytime labor is more economical.

Engineering News has made inquiries respecting the relative cost of night work, and an interesting response has come, through the courtesy of M. J. Caples, Vice-President of the Chesapeake & Ohio Northern Ry., from W. Michel, Chief Engineer of the railway. The building of this 28-mi. line—which involved the moving of 3,600,000 yd. of material—has been comprehensively treated in *Engineering News,* especially as regards the excavation (Jan. 6, 1916, pp. 6-11), filling and bridge work. Mr. Michel's letter follows:

> Owing to a greater quantity of excavation to be made at Summit Cut than at any other point on the section, it was deemed advisable to double-shift the shovel in this particular cut. Up to the present time very moderate results have been accomplished, due to causes which were almost wholly unavoidable—principally rain.
>
> The material in this cut is of a very tenacious blue gumbo, found in layers varying from 1 to 12 in. in thickness. The material loads in huge, irregular pieces, which makes it most difficult to handle on the dump and creates a danger of overturning the cars. During wet weather this material becomes very slippery, making it next to impossible to hold a trestle while dumping it therefrom.
>
> Another cause of the failure to accomplish better results is that the haul now exceeds 5½ mi. This is largely overcome by increasing the number of trains and crews. It has been found that four train crews with trains of 12 cars each are able to keep the shovel, on night shift, well engaged, where the track to the dump is in fairly good condition.
>
> The speed of trains at night is restricted to 8 or 10 mi. per hr., in order to lessen the possibility of derailments. Crews are instructed to run on "smoke" orders—that is, until they meet a train from opposite direction. The "empty" train usually takes siding so as to delay "loaded" trains as little as possible. Sidings are installed about 1 mi. apart.
>
> The very rainy spring season here prevented starting night work until May. The average output of the one shovel (a 70-ton Bucyrus) has been nearly 1,000 yd. per night, counting only the nights it was able to operate.
>
> The shovel is well lighted—both inside and out—by electricity. The small generator is driven by a turbine engine. This plant takes a negligible amount of steam to operate. The incandescent lights used are placed at the most convenient points about the shovel. The work on the dump is illuminated with fair success by acetylene lights.
>
> The book cost of night work has been less per cubic yard than that of day, owing to the fact that no track, shop or repair forces are maintained at night. It would be difficult to give any definite relative cost per yard of material handled nights to that handled days, from the data accumulated during the short time the night work has been in operation. It is the writer's opinion, however, that for an equal expenditure night work will accomplish about 75% as much as day work. This has proved out very close on other work that I am familiar with.

This report covers experience on only one job. We shall be glad to hear from other engineers and contractors as to their experience.

New York State Road Policy

The problem of New Jersey in dealing with future road building, detailed in *Engineering News* of Aug. 3, under the caption "Wanted: A State Road Policy" is not likely to be satisfactorily answered by adopting New York State's policy.

Compare these two parallel paragraphs, one from the editorial referred to and the other from a statement by Edwin Duffey, Commissioner of Highways of New York State, in the New York *Evening Post* of Aug. 5:

> New Jersey is unfortunate in this respect: Because of her early activity in road construction she has expended many millions of dollars in the construction of water-bound macadam roads, a type of construction admirably suited to the horse-drawn traffic which existed at the time the roads were built, but wholly unsuited for the motor traffic of the present day. The various makeshifts that have been tried during the past decade to enable water-bound macadam to stand motor traffic have involved large expense and have generally proved unsatisfactory in service.

> The experience of the New York State Highway Department shows, all conditions of course included, that the average cost of water-bound macadam road has been about $10,000 a mile; that of a bituminous road, penetration method, about $13,000 a mile; a first-class concrete road about $15,000 a mile; a brick pavement about $25,000 a mile. These figures include engineering and inspection. Under the present policy of the Department, the roads being built are almost wholly the water-bound and bituminous-macadam types.

These New York State roads being built from the proceeds of a second 50-year bond issue are *almost wholly* of the water-bound and bituminous (penetration) macadam type! At the Worcester Road Congress last December, Mr. Duffey stated that over 50% of the roads then under construction in New York were water-bound macadam, and presumably the present proportion is at least as much.

Almost in the same breath Mr. Duffey states that "maintenance, repair and upkeep of improved roads is the great highway problem of today," and that in 1915 it cost an average of $1,055 per mi. to maintain 2,298 mi. of water-bound macadam! The reason for this present policy Mr. Duffey does not state. Is it because New York has already spent the greater part of a second $50,000,000-bond issue on a 12,000-mi. road still far from complete and is trying to stretch the inadequate remainder over as many miles as possible?

Letters to the Editor

Relation Between Road Costs and Terminal Costs

Sir—The editorial on railway freight-rate discrimination, resulting from failure to charge for terminal expenses, in *Engineering News* of July 25, I regard as the ablest paper on this subject that has appeared for 25 years. It may interest your readers to know that a prominent Pennsylvania engineer, the late Col. Joseph D. Potts, who died in 1894, was an early advocate of the separation of road cost from terminal costs in making rates. Colonel Potts read a paper on this subject in 1892 (reprinted in 1911) in which the matter was succinctly stated as follows:

> We must have a separation of terminal and transfer charges from road charges. Terminals are costly and their expenses cannot easily be cheapened. The great future economies will be made in the movement of freight between terminals.

For your further information I inclose tables showing some typical freight rates at New York City. In shipping sugar from New York to Cleveland, Ohio, 623 mi., the official rate for many years was 17c. per 100 lb. Out of this the shipper was allowed by the trunk-line railroads 4.2c. per 100 lb. for lighterage at New York and 2c. per 100 lb. for cartage, leaving the railway 10.8c. per 100 lb. for its transportation, including terminal expenses at Cleveland.

The 900,000 tons of cement used on the Panama Canal was shipped from Jersey City and other New Jersey terminals at a cost of 60c. per ton less than it could have been shipped from New York, or $540,000.

In the case of the 425,000 tons of steel rails recently sold to the Russian Government, they could be shipped from Jersey City and other New Jersey terminals 70c. per ton cheaper than from New York, or $297,500.

I trust all interests will eventually realize what frightful waste and injustice are perpetuated by such discriminations and what is the inevitable result upon railway revenues.

FRANK L. NEALL.

102 E. Mermaid Lane, Philadelphia, Penn.,
July 26, 1916.

Measuring Railway Curves on the Arc

Sir—Referring to the question raised by Theron A. Palmer, *Engineering News*, June 29, 1916, p. 1240, the writer suggests that Mr. Palmer merely proposes one arbitrary definition of the degree of curve for another, when consideration of the various elements of a curve in relation to the radius obviates all arbitrary assumptions. From a mathematical consideration radius of curvature should be substituted for degree of curve.

The writer believes that degree of curve is a makeshift that should be discarded by engineers, who are supposed to be versed in mathematics. A knowledge of the mathematics of circles and other curves for polar and rectangular coördinates is part of the equipment of every engineer. Why not use that equipment? Does every engineer appreciate that he is applying polar coördinates when he runs in a simple railroad curve by deflection angles and chord measurements? How many engineers stop to consider that they can make practical use of the equation of a circle, $x^2 + y^2 = R^2$, or any of its derivatives?

To analyze briefly the definition of degree of curve as generally accepted and as proposed by Mr. Palmer, let R = radius; L = arc length; I = angle at center subtending arc; C = chord, and D = degree of curve; then

$$I = L/R \times 57.29578^1;$$
$$R = L/I \times 57.29578;$$
$$L = I/R \times 0.01745329;$$
$$C = 2R \times \sin \tfrac{1}{2};$$
$$R = \left(\frac{C}{2 \sin \frac{1}{2}}\right)$$

As generally used, $R = \dfrac{100\ ft.\ (arbitrary)}{2 \sin D/2} = 573.65$ ft. in the case of the so-called 10° curve; and for 60° of central angle, $L = 60 \times 573.65$ ft. $\times\ 0.01745329 =$ 600.73 ft. of arc = six 100-ft. chords.

Mr. Palmer's method would make the radius of a 10° curve 5,729.578/10 = 572.95 ft., an equally arbitrary assumption; the length of arc would be 60 × 572.95 ft. × 0.01745329 = 600 ft.; and the six chord lengths would be $6 \times 2 \times 572.95$ ft. $\times \sin 10°/2 = 99.898 \times 6$.

Either method gives correct results for the particular radius, but why not discard the idea of degree of curve and compute the arc, chord, deflection angle, etc., with reference to the radius desired?

The writer agrees that the length of a railway curve should be based on the arc length, but is it too much trouble to compute the arc length?

It may be well to add that both horizontal and vertical railway curves were placed on the Gatun locks, Panama Canal, by actual arc measurements.

J. A. KITTS.

Quincy, Calif., July 24, 1916.

Buckling of Concrete Roads

Sir—I have noticed with interest the editorial on the creeping and heaving of concrete roads, in the issue of June 22, 1916, being in a position this summer to study the faults of a concrete road in one of the southern counties of New York State. The road is a fraction over 12 mi. long. Parts of it were constructed with an aggregate of broken stone and the balance of local gravel, the sand in both cases being local material.

Where the road has been constructed of broken stone, no trouble has developed; but on the gravel-concrete parts, seven joints have buckled to date (July 26), and in each case considerable pavement has been destroyed. All breaks are located in a distance of 8,600 ft. and can be defined as follows: Sta. 1, 9.5 lin.ft. of pavement destroyed; Sta. 19, 19 ft.; Sta. 32+50, 8; Sta. 55+50, 5.5; Sta. 65+50, 5; Sta. 75+90, 10; Sta. 86, 16 lin.ft. of pavement.

[1]The derivation of these values may be found in "Engineering News," Mar. 26, 1908, p. 347.

At the joints Sta. 19 and 86, the pavement was broken up about equal distances on either side of the joint. The pavement is 16 ft. wide, 6¾ in. thick at the center, and 4¾ in. thick at the edges. The joints are ⅜-in. wood strips spaced 30 ft. apart.

The portion of road where buckling occurred is devoid of shade trees and is subjected to the action of the sun over a great area. The season has been unusually wet, and the absorption and drying out of moisture have undoubtedly played an important part. The trouble developed on a very hot day, which had recently been preceded by a spell of heavy rainfall.

Preliminary to buckling, the concrete at a joint starts to powder and small bits of concrete spall off. The slabs then rise and remain that way for perhaps a day or more, depending upon the weather conditions, before breaking up entirely. The final break usually occurs when the weather is very hot. In each case the break has occurred in the afternoon.

The most recent break (at Sta. 86) split the slab up into pieces 4 or 5 ft. square. A noticeable movement in the pavement was evident for at least 500 ft. on one side of the joint, showing plainly where the edges of the pavement had parted from the shoulder material. I also noticed in two cases an overlapping of slabs of from 2 to 2½ in. The life of the concrete at the breaks has been entirely destroyed; specimens of concrete taken out are crumbled with ease.

I suggest that if transverse concrete baffle-walls of sufficient width to prevent shearing were placed in the subgrade and the concrete pavement made monolithic with these walls, it might tend to prevent creeping of the pavement and at the same time strengthen the pavement against longitudinal cracks. S. H. E.

Sayville, N. Y., Aug. 1, 1916.

Viaduct vs. Fill at Astoria

Sir—In the June 22 issue of *Engineering News* I note an article on "Concrete Viaduct Versus Fill for Street Elevation." Although the article is not signed, it is evident, from the content, that it is written by an advocate of the fill.

Several gross errors were made in both the statement of facts and conclusions drawn as to the value of the various methods of improvement. The table (Fig. 2) gives the estimated cost of the viaduct at $57 whereas the true estimate of the committee referred to in your article was $48.18. The actual bid received for this work was $47.09. The cost of a fill ($19.40) is, in the first place, too low, and in the second place does not include various features necessary to make it a structure comparable to the viaduct.

By referring to Fig. 2 it will be noted that the fill (Scheme No. 2) slopes beyond the property line and encroaches on private property. The municipality has no power to improve on private property and as the property in question is entirely devoted to retail business the owners thereof desire to retain their basement space and would strenuously object to any encroachment thereon. The construction of retaining walls is therefore the only type of construction possible other than the viaduct.

The two types of improvement with retaining walls are quoted at $41.70 and $49.60. These costs when compared with the bid price of $46.20 for the viaduct show the viaduct to be the cheapest when its obvious advantages are considered. The viaduct allows entrance to basements through the sidewalk area, which is allowed by only one of the retaining wall schemes. It also creates a subway of very ample dimensions, which would permit the work of construction and repair of all underground systems without tearing up of pavements or interference with surface traffic in any way. It also relieved the city of the expenditure at this time of about $25,000 for installation of new water mains.

Streets are at present very narrow and the design was such as to permit the widening of the structure at a future date and with a minimum of loss of work already in place. Retaining walls could not, of course, be moved back.

The bid price of $46.20 not only included the concrete structure complete and hard surfaced, but also tile walls along each curb line, complete drainage provisions, manholes, ventilating system and lighting system.

The majority of property owners were in favor of the viaduct. The specifications did not limit the surfacing to one patented bituminous material, but called for several types of bituminous pavements as well as brick and wood block. It so happened that the patented material proved the most acceptable as to price.

In conclusion I would state that the property owners have petitioned for a wooden viaduct with hard surface pavement, in preference to a sand fill which your unknown contributor states was to be built.

G. T. McCLEAN,
Astoria, Ore., July 7, 1916. City Engineer.

[As the estimates for the four types of structure, given in *Engineering News*, were made by the same engineers (there is no "committee" referred to in the article) it is fair to assume that bids on the other types would have been as much lower than the estimates as was the bid on the concrete viaduct.

The petition for a wooden viaduct was made subsequent to the publication of the article.—Editor.]

NOTES AND QUERIES

Sacramento Weir—In the news article on the new weir to be built as part of the flood-control project of Sacramento, Calif., published on page 1204 of "Engineering News" of June 22, 1916, San Francisco was inadvertently inserted in the title and the address of the contractor (Teichert & Ambrose) was wrongly given as San Francisco, instead of Sacramento.—Frank C. Miller, City Engineer.

Formulas for Reinforced Footing Offsets—The formula for bond stress given by Clifford Older in the issue of July 6, 1916, p. 18, was printed with the left-hand term inverted; the numerical values, however, made the error apparent. The expression should read

$$\frac{V}{jd} = \frac{6{,}000}{0.92 \times 12} = 544$$

Attention is called to the value of d in the formulas on p. 19. In accordance with standard practice this is the effective depth of the footing, i.e., the distance from compression side to center of steel; the text erroneously described it as the gross depth of the footing. Further, the diagram for amount of steel, upper half of Fig. 2, p. 19, is to be read with the value f_s instead of f_c, as given both on the curve and on the scale of ordinates at the right. The diagram, Fig. 2, is applicable to offsets of any horizontal projection, so long as the gross depth is 18 in. and the net depth 12 in. The title of the diagram, "Diagram for Shear and Bond in 18-In. Footing Offset 12 In. Deep" refers to gross depth of 18 in., and not to 18-in. projection.

Water Flow Increases with Rising Temperature

By W. L. Butcher*

The fact that the flow of water against fixed resistance increases appreciably with the temperature, was somewhat of a revelation to the writer and is presented here to bring it to the attention of others who may also have been misled by the ordinarily available books on the subject. No pretense is made of revealing anything new in hydraulics.

The question arose from a conversation with a steam-fitter in a certain large industrial establishment. On a roof there was a large wooden tank, holding some 90,000 gal., which received water pumped from engine condensers at a temperature of some 110° or 120° F. From the tank 36 small pipes (2½ to 3 in.) led to various parts of the building where the water was used in manufacturing processes. The steam-fitter inquired in picturesque language why on Sunday mornings when repairs were to be made and when everyone was in a hurry to finish the work, it took longer to empty the

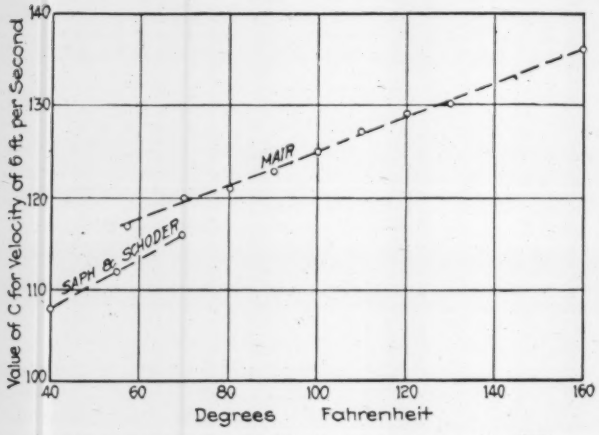


DIAGRAM SHOWING VALUES OF C IN $V = \sqrt{rs}$
At different temperatures in a 1½-in. pipe for a velocity of 6 ft. per sec.

tank than on weekdays when no one cared how long it took. The writer was at first inclined to scoff at the claim.

The only condition which appeared to be different on Sundays than on other days of the week was the temperature. The water had a chance to cool off from Saturday noon until Sunday morning. Other engineers also treated the matter very lightly and considered that there could be no practical difference in the time of emptying under the two conditions.

A search in most of the readily available works on hydraulics also revealed the fact that the matter of temperature was either entirely passed over or treated as being of no practical importance except in very small pipes and at velocities below "critical" ones. Unwin's work was the only one consulted which went into the matter at all seriously, and of this more will be said presently. In books on heating and ventilating or house piping there also was very little. On pursuing the matter still further, however, the following statements were found in papers before the American Society of Civil Engineers (*Transactions*, Vol. 47, p. 313; Vol. 51, p. 255).

*Metcalf & Eddy, 14 Beacon St., Boston, Mass.

Other experiments performed by the writers on a 2-in. brass pipe have shown that the effect of temperature on loss of head is a very important factor.

The accepted idea in this matter is that the effect of temperature is negligible in pipes of commercial size. . . After the experiments had progressed far enough and several different temperatures of water had been experimented with it became evident that there is nothing to support the notion that the effect of temperature is negligible in large smooth pipes.

Unwin, on p. 143 of his "Treatise on Hydraulics" (1907 edition) says:

The four results with a bright brass disk . . . show that the friction diminishes with unexpected rapidity as the temperature increases. The diminution is sensible even for a few degrees difference of temperature and hence it appears that a correction for temperature ought to be introduced in experiments on the flow of water in pipes and channels.

These facts are brought out strikingly in the accompanying diagram, which shows that the steam-fitter's complaint had some basis of fact. The diagram was made up from results of old experiments. The studies covering the greatest range of temperature for pipes of commercial size are apparently those of J. G. Mair, mentioned by Unwin (*Proceedings*, Institution of Civil Engineers, Vol. 84). His experiments on a 1½-in. brass pipe ranged from a temperature of 57 to 160° F. and for this range he found values of m in the formula $\frac{h}{l} = \frac{mv^{1.795}}{d^{1.2} \cdot 2g}$, the meaning of the various symbols being obvious.

For the purpose of reducing his values of m to the more familiar c in the Chezy formula, we obtain by equating the similar values of s the following for a 1½-in. brass pipe:

$$c = \frac{13.03\, V^{0.102}}{\sqrt{m}}$$

For a velocity of 6 ft. per sec. using values of m given by Mair we obtain the following results:

Temperature, Deg. F.	Value of C
57	117
70	120
80	121
90	123
100	125
110	127
120	129
130	130
160	136

Saph and Schoder experimenting on a similar brass pipe obtained the following results, as read from a diagram presented by them in the *Transactions* of the American Society of Civil Engineers, Vol. 51, p. 290:

Temperature, Deg. F	Loss of Head, Ft. per 100 Ft.
40	9.7
55	9.1
70	8.6

From which we obtain for a velocity of 6 ft. per sec. the following values of c.

Temperature, Deg. F.	Value of C
40	108
55	112
70	116

Now it seems to the writer that where well authenticated experiments are in existence showing such a range of values that within the possibilities of many practical problems it may be found that the flow of water is increased by a mere change in temperature of the water from very cold to very hot as much as 25%—and possibly more in old tuberculated pipes but concerning which no experiments are available—such possibilities should be accentuated in standard works. It is certain that the engineer who perhaps does not claim to be a deep student of the subject will gain the idea from most of the standard works, if he gets any idea at all on the subject, that the matter of temperature is of no importance.

Organizing Officers' Reserve Corps, United States Army

Provisions for officers and enlisted reserve corps, contained in the National Defense Act as approved June 3, 1916, and the regulations prescribed by the President have been made effective by War Department General Orders No. 32, dated July 28, 1916. A memorandum giving information on the Engineer Officers' Reserve Corps has been issued by the Chief of Engineers, United States Army, dated Aug. 1, 1916. The following paragraphs are reprinted for the information of engineers interested:

Applicants commissioned in the Officers' Reserve Corps will rank in the various sections according to grades and to length of service in their grades. Commissions will be issued for periods of five years. No age limits apply to the Engineer Officers' Reserve Corps.

Except as otherwise herein provided, a member of the Officers' Reserve Corps shall not be subject to call for service in time of peace, and whenever called upon for service shall not, without his consent, be so called in a lower grade than that held by him in said reserve corps. In time of actual or threatened hostilities the President may order members of the Officers' Reserve Corps, subject to physical examination, to temporary duty with the Regular Army, or as officers in volunteer or other organizations that may be authorized by law, or as officers at recruit rendezvous and depots or on other duty. They may be promoted to vacancies in volunteer organizations or to temporary vacancies in the Regular Army, as prescribed in the act. While reserve officers are on such service, they shall be entitled to the pay and allowances of the corresponding grades in the Regular Army.

Department commanders and the Chief of Engineers when authorized by the Secretary of War may order reserve officers of their departments or corps to duty with troops in the field or at field exercises or for instruction for periods not to exceed 15 days in any one calendar year. While so serving, such officers shall receive the pay and allowances of their respective grades in the Regular Army. These periods will not be extended except with the consent of the reserve officers concerned.

The examining board will ordinarily be composed of one officer of the Corps of Engineers, one member of the Engineer Officers' Reserve Corps and one officer of the Medical Corps or the Medical Officers' Reserve Corps.

The mental examination of no applicant will be undertaken who, in the judgment of the board, is not physically qualified to discharge in active service all the duties of an officer of the grade in which the applicant seeks a commission in the Officers' Reserve Corps; nor of anyone who has any mental infirmity or deformity of body, or whose moral fitness has not been duly established.

No person shall be examined for appointment in the Engineer Officers' Reserve Corps unless he has a letter from the Chief of Engineers authorizing his examination. Such a letter to an applicant will be the acknowledgment of the receipt of his application.

If an applicant has served in the Regular Army of the United States, or in any of the volunteer forces of the United States, or in the organized militia of any state or territory or the District of Columbia, he shall submit his discharge papers for each term of service; if still in service of any of the organizations named, he shall submit recommendations of his immediate and higher commanders.

If an applicant has attended or pursued a regular course of instruction in any military school or college of the United States, or has graduated from any educational institution to which an officer of the army or navy has been detailed as superintendent or professor pursuant to law, he shall, if a graduate, be required to present a diploma or certificate of graduation from such military school, college or educational institution, or, if not a graduate, a certificate showing the amount and character of training, theoretical or practical, satisfactorily completed thereat.

Every applicant will be subjected to a rigid physical examination which shall include the ordinary analysis of the urine, and if there be found to exist any cause of disqualification which might in the future impair his efficiency as an officer, he will be rejected. Defects of vision resulting from errors of refraction which are not excessive and which may be entirely corrected by glasses do not disqualify unless they are due to or are accompanied by organic disease.

Candidates for appointment in the Engineer Officers' Reserve Corps will be examined either (a) for duty with combatant engineer troops or other duties in the service of the front, or (b) for special service on the lines of communications or other points in rear, including engineer work in connection with seacoast defenses, as hereinafter indicated. Officers appointed under (b) will not ordinarily be assigned to combatant duties, but will be subject to such assignment whenever needed. The examinations shall be especially directed to ascertaining the practical capacity of the applicant, and the record of previous service and training of the applicant shall be considered as a part of the examination.

Military experience or training in the Regular Army, Volunteers or National Guard, or at training camps or educational institutions, will be noted and reported by the board and considered in making the recommendations.

A. QUALIFICATIONS FOR RESERVE OFFICERS, SERVICE OF THE FRONT

1. For First and Second Lieutenants

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or have qualified for the grade of junior engineer, civil, electrical, or mechanical or higher grade in the civil service, or he must be a graduate from an approved engineering college, or have been in the active practice of engineering for at least two years.

2. For Captains

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must either hold or be eligible for the grade of assistant engineer in the Engineer Department at large, or a corresponding engineer grade in the civil service in another department of the Government service, or have held a commission in the Corps of Engineers of the Regular Army, or shall be a professional engineer not less than 28 years of age, who shall have been in the active practice of his profession for at least 8 years and have had responsible charge of work as principal or assistant for at least 2 years. The graduation from a school of engineering of recognized reputation shall be considered as equivalent to 2 years of active practice.

(c) Knowledge of the principles of military organization and operations, as illustrated in Infantry Drill Regulations, Parts I (to include School of the Company) and II, and Field Service Regulations, Part I and Part II (Articles I, II, IV, VI); and of the general principles of field fortifications, as illustrated in the Engineer Field Manual, Chapter V.

3. For Majors

(a) The applicant must be an engineer in the active practice of his profession or some business immediately connected with, or concerned in, engineering matters.

(b) He must hold the grade of Assistant Engineer in the Engineer Department at large, or corresponding engineer grade in the civil service in another department, or have held a commission in the Corps of Engineers of the Regular Army not more than two grades below that for which he desires to be listed, or shall be a professional engineer not less than 35 years of age, and shall have been in the active practice of his profession for 15 years, who shall have had responsible charge of work for at least 5 years, and shall be qualified to design as well as to direct engineering work. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to 2 years of active practice.

(c) In addition to fulfilling the qualifications given in paragraph 3 (a) and (b), the candidate will be required to pass an examination on the following subjects:

Drill Regulations—Parts I (School of the Company and Battalion only), II, III, Infantry Drill Regulations.

Field Service Regulations, entire text.

Duties of Engineer officers and troops in war, as illustrated in the Engineer Field Manual and Bulletin No. 4, Vol. I, of the office of the Chief of Staff.

Coöperation between the various arms of the service, as illustrated in "Technique of Modern Tactics" (Bond and McDonough), Chapters VIII, IX, XI and XII.

All examinations will be oral.

B. QUALIFICATIONS FOR RESERVE OFFICERS, SPECIAL SERVICES

Candidates desiring appointment in special services must be qualified for at least one of the duties assigned to the Corps of Engineers by the following extracts from Army Regulations:

1493. The duties of the Corps of Engineers comprise reconnoitering and surveying for military purposes, including the laying out of camps; selection of sites and formation of plans and estimates for military defenses; construction and repair of fortifications and their accessories; . . . the installation of electric power plants and electric power cable

connected with seacoast batteries; . . . construction and repair of military roads, railroads and bridges; military demolitions; . . . In time of war within the theater of operations it has charge of the location, design and construction of wharves, piers, landings, storehouses, hospitals and other structures of general interest, and of the construction, maintenance and repair of roads, ferries, bridges and incidental structures, and of the construction, maintenance and operation of railroads under military control, including the construction and operation of armored trains.

No oral or professional examinations will be required, but recommendations of boards will be required in lieu of such examinations. Candidates will submit evidence of their actual employment in corresponding or higher positions in civil life and references to persons under whom they have been or are employed.

Reserve officers from the following civilian occupations will be required for the special services of the Corps of Engineers: Bridge engineers, constructing engineers (earth and concrete), constructing engineers (wharves, piers and buildings), electrical engineers (for small plants and power lines), highway engineers, mining engineers (skilled in tunneling and use of explosives), railroad engineers (construction and maintenance), railroad operating officials, sanitary engineers, topographical engineers.

There is an opportunity also for engineers to engage in professional service under the Quartermaster Corps, especially the service of technical inspection of supplies. A division of Reserve Quartermaster Officers is provided, "whose duties are not administrative" and who do not need knowledge of army administration, transport regulations, transportation, military law, hippology, etc. Among the fields of knowledge and experience stated in General Order No. 32 are railroad operating and mechanical department; superintending engineer or inspector of construction and repair, navigation company; shipconstruction companies; automobile, wagon and machine manufacturing companies; president, secretary or manager of any large business; building or construction company; civil, mechanical, electrical, sanitary and structural engineering.

Cleveland Engineering Society to the Rescue

By C. E. Drayer*

In recent years building-code legislation in Cleveland has been drafted by the building department of the city, acting with a Joint Building Code Committee composed of five members from the building-code committees of the Cleveland Engineering Society, the Cleveland Chapter of the American Institute of Architects and the Builders Exchange. There was no little surprise, therefore, when on about May 1 the Cleveland Engineering Society was informed that an ordinance revising the plumbing section of the building code had been initiated and introduced into the City Council by the Journeymen Plumbers' Union. It appeared that the ordinance was likely to be put through the council without taking the advice of the Joint Building Code Committee. This committee felt that it could take no action in the matter without being requested to do so by the council.

It was clear that if there was to be any opposition to the proposed revision it would have to be organized by the Cleveland Engineering Society. The ordinance had advanced to the hearing stage on a Friday preceding the third reading and passage on the next Monday night. Quick and vigorous action was necessary. Letters were written to the secretaries of the various civic organizations in Cleveland, explaining briefly a few of the worst features of the proposed code and asking that representatives be present at the hearing and assist in getting the code considered in its many complex elements on its merits. The response was so generous that the council committee room in the new City Hall was dedicated at its first hearing by the attendance of an unusually large number of citizens and by the display of a much livelier interest than is usually shown at committee hearings. The engineering society asked the council committee to refer the proposed ordinance to the Joint Building Code Committee and suggested that this committee during consideration of the plumbing legislation be augmented by five representatives of the Master Plumbers' Association and five of the Journeymen Plumbers' Union. After a strenuous two hours, during which the chief plumbing inspector, who is also president of the Journeymen Plumbers' Union, could show no good reason for immediate passage of the ordinance, postponement for one week was secured.

During this week's stay the Joint Building Code Committee, already mentioned, concluded it might take a hand in the affair after all without being requested to do so by the City Council. Accordingly, it held a meeting to which it invited three master plumbers and the president of the union plumbers. The latter excused himself from attendance on the plea that he was in the employ of the city. At this meeting it was unanimously decided that the only thing to do was to go into the hearing prepared to discuss the code at whatever length might be necessary, but to make strong appeal for postponement of action until fall. At the council-committee hearing the Joint Building Code Committee, with a large delegation backing it, was successful in securing the desired postponement. At that time the council committee planned to hold a hearing each Friday through the summer vacation of the full council, which would give ample time to get the plumbing section of the code revised—and it does need revision. Later on, however, the council committee decided to dispense with the proposed hearings and to leave the proposed ordinance in the hands of the Joint Building Code Committee, augmented as suggested by the engineering society, with the understanding that this enlarged committee will report next fall.

*Secretary, Cleveland Engineering Society, Cleveland, Ohio.

Spaulding Dam To Be Raised from 225 to 260 Ft.

By F. G. Mudgett*

As described in *Engineering News,* Dec. 11, 1913, p. 1163, and June 3, 1915, p. 1057, the Spaulding dam on the South Yuba power development of the Pacific Gas and Electric Co. is designed eventually to be 305 ft. high. For its initial use, however, it was completed only to a height of 225 ft. Contracts have just been signed for a further elevation of 35 ft., bringing the height up to 260 ft.

The dam is located on the South Yuba River in the high Sierras of Nevada County, California. The idea of damming the waters of the South Yuba at that point had presented itself to the company's engineers as early as 1906, but the plans of the engineers were postponed on account of the great disaster of that year. But a start was finally made, and the diversion of waters from the South Yuba River at the dam through tunnel and canal into Bear Valley and for the construction of a power house in the Bear River Gorge, some 9 mi. below Lake

*Engineering Department, Pacific Gas and Electric Co., San Francisco, Calif.

Spaulding, at the point where a static head of 1,375 ft. was obtainable, was put under way and completed by Thanksgiving Day, 1913.

From the Drum power house it was proposed to utilize the water after its release several times over in its course through mountain and valley down to the point of its arrival in the City of Auburn, about 47 mi. below. The fall of water between the two points is approximately 4,300 ft., and it was found possible to survey sites for a chain of no less than three power developments in all. Altogether the plans called for an aggregate development of something like 162,000 hp.

In December, 1915, work on the Clipper Gap (Halsey) and Auburn (Wise) hydro plants was taken up where it had been abandoned in 1913. As these power houses will be completed this year, it becomes desirable to raise Spaulding dam to provide a greater stored water-supply for these stations, which will hold up the average power load during the dry months of the year.

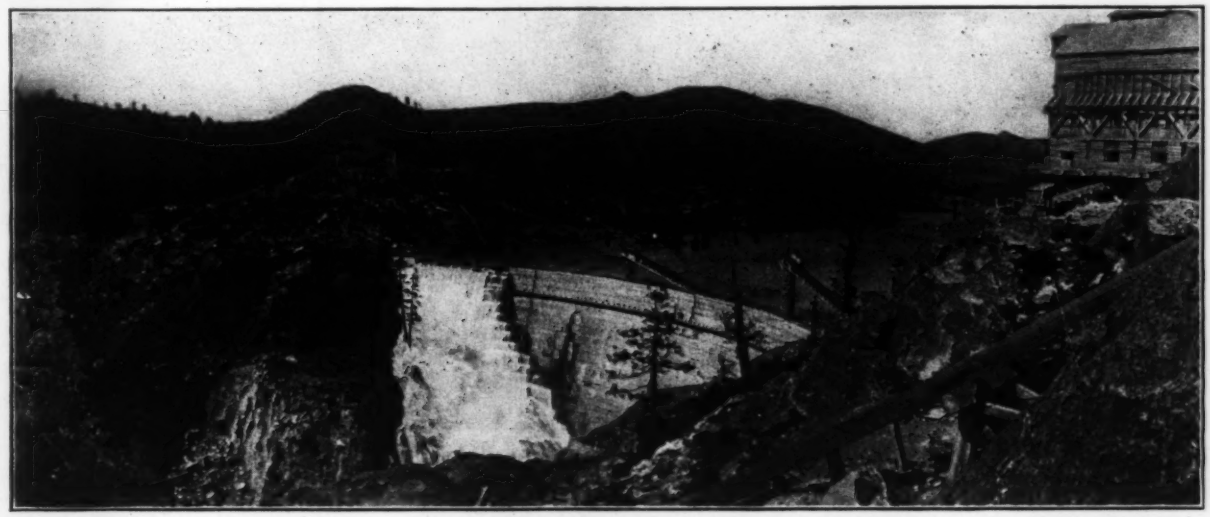
Raising Spaulding dam to a height of 260 ft. from its present height of 225 ft. and building the two necessary concrete spillway dams will increase the available storage in the lake by 20,400 acre ft., and the average available output during the short-water season from the Drum, Halsey and Wise power plants by 5,100 kw. over and above the output that can be obtained with the present height of the dam.

The dam itself is arched in plan and is of the type developed by the engineers of the company. It features a varying radius of the upstream side at different elevations, so that the pressure is kept as nearly constant as possible; in other words, we have what is called a "constant-angle arched dam," which gives a very desirable structure since the arch action in the dam can be utilized to a maximum degree at each elevation, tending greatly toward economy of section. The present Spaulding dam is provided with sufficient concrete in its section of the arch above El. 4,660 ft. so that it will stand an extension of 35 ft. in height above the present crest elevation (4,825 ft.) without any addition to its thickness.

In the year 1913, 153,806 cu.yd. of concrete was poured, and now in raising the structure to a height of 260 ft. about 16,000 cu.yd. will be added in the main dam. There will be two concrete spillway dams entirely distinct from the main dam, located in an adjoining cañon. Spillway dam No. 2 will contain less than 1,000 cu.yd., and spillway dam No. 3 about 7,500 cu.yd. of concrete.

The site of the construction plant is some 2 mi. from Smart, a small station on the Southern Pacific in Nevada County. From here at the beginning of the undertaking, standard and narrow-gage lines were run to a point high above the work, for easy delivery of machinery and material. The speed requirements necessitated at the dam a plant installation of a character that would allow for the placing of large masses of concrete daily. The plant consisted in 1913 of four No. 14, 42-cu.ft. Smith mixers, each of which could deliver 1 cu.yd. of concrete every 2 min., making it possible to place as much as 1,300 cu.yd. of concrete per day as an average daily output for one month. The best month's record shows 40,485 cu.yd.

It was the perfect gravity system that made it possible to distribute this tremendous mass of concrete over the large area of the dam in the short time. The only limitation arose from the transportation problem of getting the concrete materials to the front. In the present work only two of these mixers will be operated, as with the increasing height of the dam it becomes necessary to use a tram on a trestle, in place of the main chutes. The mixers empty their contents into a chute 2½ ft. deep and 2 ft. wide, which zigzags down the cañon to the dam. There the concrete was picked up by a 24-in. conveyor belt and distributed to the dam. The chutes will now discharge to a hopper for tram-car delivery. The concrete to the spillway dams will be delivered by a small railroad running across the main dam after its completion.



LAKE SPAULDING DAM AT HEIGHT OF 225 FT. SPILLING 300,000 SEC.-FT.

On account of the limited time for completion, bids were received early in July for handling the work entirely under contract, and it has been found advisable to let a contract for the completion of the work on or before Dec. 1, 1916.

The construction work will be carried on by Twohy Brothers, using the plans and specifications of the company, with P. M. Dowling as chief engineer and H. C. Vensano, civil and hydraulic engineer, as chief assistant engineer, having O. W. Peterson as resident engineer to supervise and inspect the work at the front.

Iron Culverts Used for Arch Construction in Arizona

The high cost of packing materials for culvert construction on new county roads in the mountain districts has led to considerable use in Arizona of corrugated steel for culverts—even in arch culverts as large as 12-ft. diameter.

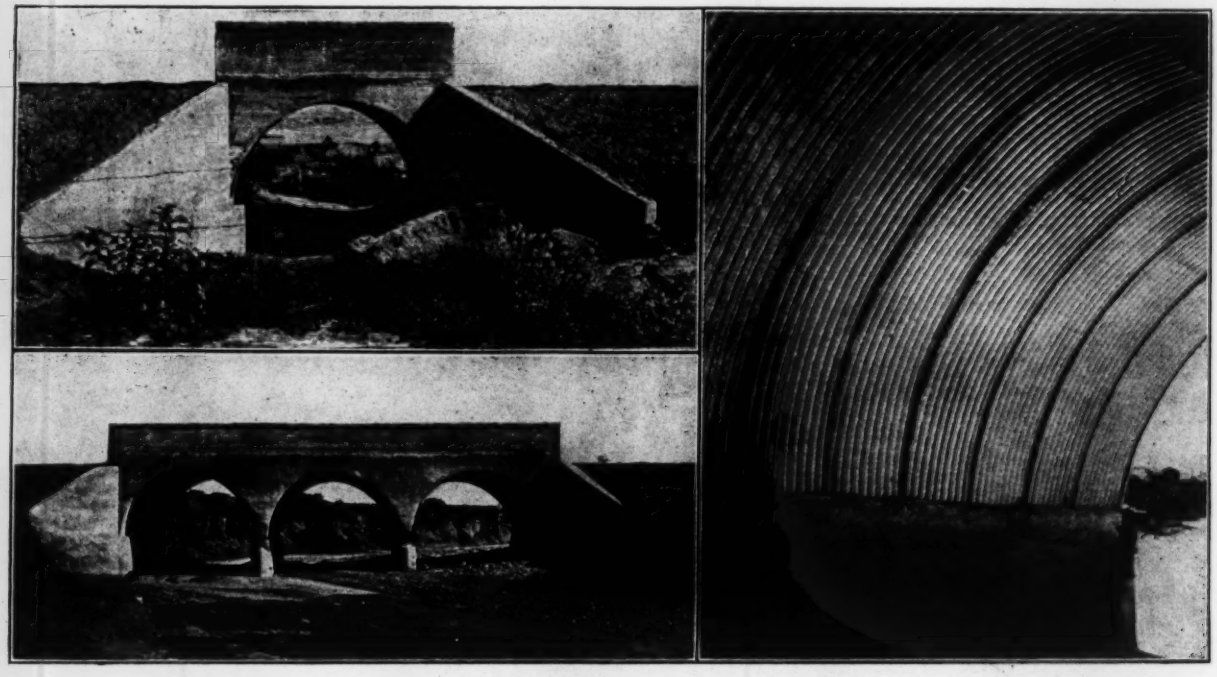
Figs. 1 and 2 show culverts of this type. The metal comes in plates bent to a quadrant. They are riveted in the field to form semicircular arches. Concrete spandrel walls are used, but the entire load of the fill is carried on the thin corrugated arch sheet—about $\frac{1}{10}$ in. or No. 10 gage, which rests on the abutment.

Gravel Cover on Bridge Floors Must Be Carefully Spread

There is some danger in overloading a highway bridge by unduly thickening the gravel cover to the floor, according to the State Highway Commission of Minnesota. In the *Minnesota Highway Journal* it is stated that with but few exceptions all new steel bridges for which plans were furnished by the Commission are built with concrete slab floors. All such floors should have a gravel wearing surface placed on them, and the same protection should be placed on all reinforced-concrete bridges. It is very important that this covering be thick enough to protect the slab from the horses' calks, and from the mud-hooks on traction-engine wheels, but it is also important to prevent making it so thick that the bridge will be overloaded.

On steel beam spans and short concrete bridges where the extra weight is not serious, the plans of the department call for a gravel covering 4 in. thick at the curb and 5 in. thick at the center of the roadway. But on truss bridges the gravel should be only 2 in. thick at the sides and 4 in. thick at the center. It is not uncommon to find truss bridges with the gravel placed level with the top of the curb and then crowned at the center, giving an average thickness of 9 instead of 3 in.

The weight for each inch of gravel covering on the floor of a 100-ft. truss span, 80-ft. roadway, figured at 120 lb. per cu.ft. is 8.4 tons; where it is made 6 in. extra in thickness the overload is 50 tons. This is a serious overloading and should be carefully watched.



FIGS. 1 TO 3. CORRUGATED-STEEL ARCH BRIDGES ON ARIZONA ROADS

Figs. 1 and 2 (on left)—Single and triple arches of typical design. Fig. 3 (on right)—Near view of under side of one of the arches

An arch of this type costs less than a concrete culvert and is built more quickly, but its use is confined to isolated places where concrete materials are scarce and transportation costs high.

The thickness of the spandrel at the grade of the roadway is 12 in. with a batter of $\frac{1}{4}$ on 1. The metal has no fastening to the spandrels other than the natural bond of the iron to the concrete. Sometimes rubble masonry is used for the spandrels.

FIG. 4. DIAGRAM SHOWING METHOD OF SUPPORTING METAL AT ABUTMENTS

The way of supporting the arch on the abutments is shown in Fig. 4, and Fig. 3 is a view of the underside of one of the arches showing the sections of corrugated metal.

Another Street Tunnel is to be built in Los Angeles, Calif., to carry Second St. through Bunker Hill. The first plans for the work were for two tunnels side by side, each 30 ft. in width. On July 5 it was decided to substitute a single tunnel 60 ft. in width. The plans and specifications for the work are being prepared by R. W. Stewart, Assistant City Engineer.

News of the Engineering World

Flood in West Virginia

Floods in the Coal River district in West Virginia on Aug. 9 caused a considerable loss of life, wrecked many houses and damaged coal and railway property to the extent of hundreds of thousands of dollars. Professor Henry, of the United States Weather Bureau informs *Engineering News* that there are no official observing stations in the Coal River drainage area, and that the records for the nearest stations show little or no rain on or for several days before Aug. 9—in fact the Weather Map for Aug. 10 showed no rain in all West Virginia. Professor Henry thinks the floods were due to a heavy rain confined to the Coal Creek watershed in Boone County. Later information from the Weater Bureau shows the following rainfall in inches for the three West Virginia stations nearest the Coal Creek watershed:

	Aug. 8	Aug. 9	Aug. 10
Charleston	...	1.10	...
Kanawha Falls	...	1.50	...
Heriton	0.22	0.10	0.50

At Point Pleasant, where the Kanawha (which receives Coal River) joins the Ohio the following river stages were observed from Aug. 7 to 11, inclusive: 7.4, 8.2, 8.1, 13.6, 10.9.

Reports state that Cabin Creek, a tributary of the Coal, began to rise rapidly at 8:30 a.m., Aug. 9. Apparently the flood was at its height in that stream and in Sing Creek, Little Coal River and Big Coal River about the middle of the same day, the flood waters soon reaching the Kanawha. Some of the villages reported devastated were Acme, Dames, Eskdale, Kayford, Oakley and Ronda. A considerable mileage of main and branch tracks of the Chesapeake and Ohio Railway were reported washed out. Dr. S. L. Jepson, Health Commissioner of West Virginia, sent men to protect and assist the people in the flooded district.

It appears that the valleys in the flooded sections are very narrow and their sides very steep, giving a quick runoff. In such a valley habitations generally hug close to the banks of the stream. The fact that the flood occurred in broad daylight would seem to have given time for people to rush from their houses before they were overwhelmed, especially as the flood appears to have been wholly due to runoff and not to the sudden release of waters stored behind a dam. All the scanty evidence available indicates that this must have been a rainfall of great intensity. This makes it all the more a cause of regret that the actual rate and total will never be known.

Lake Toxaway Earth Dam Fails

The earth dam forming Lake Toxaway in the mountains of North Carolina about 50 miles south of Asheville, N. C., failed on Aug. 13 and drained the lake. The water passed down the Toxaway River into the Chuga River and eventually into the Savannah River. The first 15 miles of the flow is through sparsely settled territory where little damage could be done and below that the river channels easily took care of the flood.

The Lake Toxaway Dam, built in 1902 as part of a hotel and resort scheme, was of thoroughly packed and pounded clay, 385 ft. long on the crest, 62 ft. high at the lowest part of the gorge and 20 ft. wide on the crest. The slopes were about 1 on 2 and the dam was 230 ft. wide at its deepest section. About six years ago some fears for its safety led to strengthening by dumping in riprap around the base.

At the time of the July floods of this year it was reported that the dam had failed but this proved not to be so, although it is possible that it was weakened then. At 6 a.m. on Aug. 13 a leak appeared in the base of the dam which widened until complete failure took place about twelve hours later.

After the failure of the dam the following letter was received by D. N. Showalter, Civil Engineer, of West Chester, Penn.

"I noted with much interest the accounts of the failure of the Lake Toxaway Dam. During the winter of 1912-13, I was located at Lake Toxaway investigating the water-power possibilities of the various streams around there.

"The dam was built in the early nineties, and had a heavy stone wall core which was probably 6 or 8 ft. thick at the bottom, narrowing to perhaps 2 ft. at top. The top of the core was some feet below the water surface. The balance of the dam was built of earth fill which contained considerable clay. During the winter of 1911, the waves drove so hard from the three miles of lake surface that they injured the upstream face a little. In the following spring and summer rock was blasted from the hillside at the north end of the dam, and dumped down over the upstream side to act as paving.

"The dam was built on a solid rock foundation which had from one to two feet of earth cover. The rock is not stratified and has practically no open crevices. The site is in fact ideal. When I was there, there had been for several years a small leak near the bottom just north of the stream bed. In my opinion, this was due to the thickness of the core wall, which no doubt had been cracked by the settlement and small movements of the dam.

"The rainfall here is exceeded in only one locality of the United States. Probably the recent heavy rains overtaxed the spillway (which was cut from solid rock at the south end of the dam) and caused several feet of additional pressure on the dam which had been weakened by leakage during the past years.

"Such a dam as this should be built with a thin flexible concrete core wall, well grooved into the rock, heavily reinforced in both directions and extending well above the water surface. Such a wall should not be more than 10 or 12 in. thick, and will then be elastic enough to follow small movements of the dam without injury. It is probable, too, that the side slopes of this earth dam were not as flat as conservative practice would dictate. It is indeed surprising that the dam built on so ideal a site should fall."

Harbor Changes at St. Paul

The recent Federal River and Harbor Bill provides for a survey by the War Department of the harbor at St. Paul, Minn., with a view toward determining whether the Mississippi Channel can be changed near the West Side Bluffs. Steps have been taken to inaugurate this work.

The harbor lines at St. Paul have been the subject of investigation and discussion for a number of years. In 1912 the River and Harbor Commission of St. Paul recommended the shifting of the channel of the river away from St. Paul proper in order to make more room for the proposed new union depot facilities and also to acquire certain lands for industrial purposes. The city engineering department was ordered to make the necessary surveys and soundings and $1,200 was appropriated for the work. The area between the old and the new channel was 390 acres and added to the old river bed with its 323 acres, made a total of 713 acres transferred to the north side of the river. The estimated cost of acquiring land for the new channel with 200-ft. levees on each side and excavating the new channel was two million and a quarter dollars. Nothing further was done on this project as the union depot company was working on plans for a new union depot and track layout and the amount of land required by that project was not definitely determined.

The railroads in 1915 prepared a plan which changed the harbor lines but it was disapproved by the Chief of Engineers, on the ground that the change was not for the benefit of navigation and that no provision was made for river traffic on municipal harbor facilities. The union depot company then withdrew its plans and stated that it would prepare a layout which would not require changing the harbor lines of the river. This was early in 1915 and the company is still working on this plan. The Commercial Club of St. Paul then took up the question of the river channel change and advocated moving it still farther away from the city and close up against the bluff on the south side, in this way acquiring 1,150 acres of land. This proposed channel shortens the river 1.2 mi., increasing the fall of the river 0.7 ft. The matter rested there when Congress put a temporary stop to the controversy by ordering the survey and report which are about to be made.

New Potomac Bridge Plans

The new bridge across the Potomac River, at Washington, D. C., to replace the old Aqueduct Bridge is to be named the Key Bridge in honor of Francis Scott Key, the author of the "Star Spangled Banner," whose home in Georgetown, D. C., near the bridge site, is still preserved. It has been announced that the bridge will be located just downstream of the present bridge, running from Rosslyn, Va., to a point in Georgetown on M St. between 34th and 35th St. The structure will be a series of five reinforced-concrete arches high enough to accommodate the river traffic without a draw. Navigation of everything but barges and small river craft heads below the site.

The design of the bridge, for which Congress has appropriated $1,200,000 is in charge of the Corps of Engineers, United States Army. The architectural features are to be supplied by N. C. Wyeth, a local architect.

Philadelphia Wants Engineers

Every department of the municipal service of the City of Philadelphia requiring technical engineers has found it difficult to secure men. The positions pay from $900 to $2,500 and these figures have not proved inviting to the high class of men it has been hoped would be secured. To meet the situation, the Civil Service Commission has temporarily suspended the regulations requiring that positions cannot be filled except by those having a citizen's residence in Philadelphia for at least two years prior to appointment. The Commission is advertising for men in other cities, as follows:

> Men wanted in the technical engineering service of the city, including draftsmen, structural and architectural, at salaries ranging from $900 to $2,500 per annum. Work on subways, elevated railways, piers, sewage-disposal plants, grade crossings, bridges and streets. Employment continues for from one to two years and in many cases permanent. For additional information apply to the Civil Service Commission, Room 875, City Hall.

Under this change of rules a number of engineers and draftsmen have come from other cities and are now working in Philadelphia's several departments, such as Public Works, Transit, and Wharves, Docks and Ferries.

Rail Breaking After Ten Years Wrecks Train

The Interstate Commerce Commission reports this week that investigation of a wreck on the Western Maryland Ry., Jan. 7, 1916, shows the cause to be a 90-lb. top-of-ingot rail breaking after ten years of service. A feature of the case is that the failure was not a single break but a complete shattering of the rail for a length of 11 ft. Of this length 56 pieces were recovered. Traces of several old splits in the rail head and between head and web were discovered. A longitudinal fissure of considerable length was found, being identified as a development from bad, seamy condition of the steel.

The failure is officially attributed to unsound condition of the steel. In no previous case has this cause produced trouble after so long a period as ten years of main-line service.

H. W. Belnap and J. E. Howard made the investigation.

Cure for Transverse Fissures Claimed Found

The discovery that transverse fissures in rails can be prevented because they result from two specific preventable defects in mill practice is announced by P. H. Dudley, Consulting Engineer, New York Central R.R., in an official bulletin just published by the railway. The actual development of the fissures is "detail growth" under traffic from checks or small rupture planes produced before the rail leaves the rolling mill.

The two mill causes are improper cooling from the rolling heat and the subsequent gagging to straighten the rail before shipment. The former cause, says Mr. Dudley, produces delayed transformations of the structural components of the metal, and has the result of forming a hard non-ductile core in the middle of the head. The gagging then breaks this core, the surface of parting passing between the grains of the metal. Under traffic this break surface grows but now cuts through the grains,

giving rise to the smooth specular surface outside the nucleus of the fissure as seen after complete rupture.

If the gagging is done by stretching the head, the gagging ruptures the hard core of the head in tension. If the ram in gagging bears on the head, so as to stretch the base, a shearing fracture of the hard core is produced. Two types of transverse fissure correspond to these two conditions, says Mr. Dudley, the "intergranular" type and the "coalescent" type, the latter characterized by horizontal or inclined and branching surfaces of rupture.

As complete preventive of these defects, Mr. Dudley recommends reheating the blooms before rolling to the finished rail. He says that no transverse fissures have developed in basic open-hearth rails made under New York Central specifications and rolled from reheated blooms.

Galveston Causeway Progress

The causeway across Galveston Bay to replace the one washed out by the hurricane of a year ago is still the subject of conference. Last winter a committee of engineers representing the county, the steam railroads and the electric railroads considered a number of different designs for the new crossings, but never reached any decision although at one time it was reported that the design selected comprised a section of 28 reinforced-concrete arch spans similar to the old design; that is, with 70 ft. spans and 3,600 ft. of 50-ft. arch spans over the old causeway section. This structure was to cost about $1,500,000.

It is now reported that the conference is again to attempt the selection of a design and to aid in this work a board of three outside engineers is to investigate and report on the project. On this board Prof. A. N. Talbot, of the University of Illinois, has been named by the steam railroad interests and Prof. George F. Swain, of Harvard University, by the county and the electric lines. These two engineers are to select the third member of the board.

A Surface-Car Collision Killed 25 persons and injured 65, near Johnstown, Penn., on Aug. 12. Press dispatches state that "the motorman lost control of his car and it crashed into another at a switch." The accident occurred on the Southern Cambria Ry., between Echo and Brookdale.

The Austin, Tex., Dam continues to be the object of expert attention. It has now been announced that Edward Wegmann, Consulting Engineer, New York City, has been asked to report on the condition of the dam and to suggest necessary changes and improvements, especially in regard to the automatic crest gates.

A City Board of Public Utilities, to supervise and regulate the various public-utility corporations in New Orleans, La., is provided for by recent state legislation. The board will be composed of a City Commissioner of Public Utilities and four other members. The members of the board are to be appointed by the governor.

The Three Boston Engineers ordered reinstated in the Public Works Department of that city by a recent court decision will have to fight their case in the State Supreme Court, to which Mayor Curley has appealed. The mayor offered to pay the engineers for the time between their political decapitation and the court order reinstating them if they would resign but they refused to do so.

The Office of Public Roads and Rural Engineering is to receive a Federal appropriation of $724,505, according to the provisions of the Agricultural Appropriation Bill as amended by the Senate. Of this amount, about $320,000 is to be applied to work in connection with good roads; about $200,000 is made available for irrigation investigations, most of which is to be applied to investigations in connection with the use of underground water; and $94,720 is appropriated for drainage investigations. In addition to this, it is probable that this office will be placed in charge of the work of supervising the Federal appropriation for aid to state road construction. The expenses of the force to carry on this work, however, will be paid directly from that appropriation.

An Appraisal of the Beaver Valley Water Co., which operates water-works plants in western Pennsylvania, has been made by the Public Service Commission of Pennsylvania. Complainants appealed for a reduction of the company's rates and claimed that the true valuation of the company's property was $670,000, whereas the company claimed a valuation of $2,600,000. The commission has appraised the property at $985,000 and allows the company to charge rates to yield an annual return of $135,950. This is based on a 7% return on the appraised valuation, plus an allowance of $63,000 for operating expenses, maintenance and taxes and $12,000 for depreciation. The company has outstanding capital stock representing $1,000,000, bonds for $1,063,000 and notes for $184,000.

Municipal Ownership of Water-Works at Denver, Colo., was involved in a decision handed down by a lower court on July 22, 1916. On Aug. 21, 1915, the Denver Public Utilities Commission, a city board charged with establishing municipal ownership of water-works in Denver, contracted to buy the Antero Reservoir and High Line Canal from the Antero and Lost Park Reservoir Co., of Denver, for $1,050,000. Injunction procedings followed. The decision just handed down seems to uphold the legality of the purchase except for certain alleged contract rights of a third party. In order that issues may be joined to settle these an injunction which holds up the purchase meanwhile was granted. Some opponents of the purchase claim that these issues cannot be cleared and other parties hold that the obstacle will soon be removed.

Work on the Imperial Valley Canals in 1915 is summed up in Superintendent Ray S. Carberry's report to the president and board of directors of the Imperial Water Co. No. 1, which irrigates 100,000 acres of California land. Cleaning was carried on over 294 mi. of canal at a cost of about $102 per mi., as compared with 179 mi. in 1914 at a cost of $113. Thirty miles of canal were cleared at a unit cost of $69; 18 mi. were cleared in 1914 at a cost of $4,343 per mi. (according to the report). Brush was cut on 223 mi. of canal at a cost of $34 per mi.; 331 mi. of brush were cut in 1914 at a unit cost of $33. The repair cost amounted to $1,897.78, as against $1,501.51 for the preceding year. Disk and grader outfits were used on the banks, with the result that the latter were widened, vegetable growth was discouraged and roads were made for caterpillars, dredges and other travel. This work cost $6,258.78 in covering 307 mi. of canal, or $20.39 per mi.

Railway Investigating Commissions are to be set at work by Canada and by the United States. The Canadian commission has already been appointed and consists of Alfred H. Smith, President of the New York Central Lines, Chairman; Sir Henry Drayton, Chairman of the Canadian Board of Railway Commissioners, and Sir George Paish, the famous British financier. The Canadian body's official title is the Railway Board of Enquiry. The Board is to investigate the general problem of transportation, the status of each of the three great transcontinental railway systems, with special reference to the territories which each system serves, the service it is capable of performing in the general scheme of transportation, physical conditions, equipment and capacity, methods of operation, steamship connections and financial status. It is further to consider whether the reorganization of any of the systems or their acquisition by the Government is necessary. The compelling cause for the appointment of this Board in Canada is understood to be the serious deficit which faces most of the Canadian railways except the Canadian Pacific. The extent to which the Government is bound up with these corporations through its guarantees, securities, etc., may make it necessary for the Government to take over the properties and operate them. In the United States, according to the terms of a Senate resolution approved by the House on July 15, a commission made up of five members of the Senate Committee on Interstate Commerce and five members of the House Committee on Interstate and Foreign Commerce is to investigate the Government control and regulation of interstate and foreign transportation, the extent to which present regulation is efficient in protecting the rights of shippers and carriers and promoting the public interest, proposed changes in the organization of the Interstate Commerce Commission and the laws under which it operates, and Government regulation and control of public utilities as compared with Government ownership and operation. The appointment of the commission was recommended by the President in his Annual Message last December. Senator Newlands, the introducer of the resolution and Chairman of the Senate Committee, will probably be one of the members of the Committee, and Representative William C. Adamson, of Georgia, Chairman of the House Committee, will be another member.

PERSONALS

Ross Shreve has resigned as City Engineer of Tillamook, Ore.

H. P. Kerr has been appointed City Engineer of Tillamook, Ore.

C. E. Coles, of York, Penn., has been appointed State Road Superintendent of Westmoreland County.

A. B. Oyler, of Newville, Penn., has been appointed State Road Superintendent of Fayette County, succeeding E. L. Clemmer, resigned.

Nial Rook, of Clearfield, Penn., has been appointed State Road Superintendent of Indiana County, succeeding C. H. Harrison, resigned.

G. N. Wood, recently City Engineer of Chanute, Kan., is now City Engineer of Douglas, Ariz. He was formerly Assistant City Engineer at Douglas.

E. F. Musson, M. Am. Soc. C. E., has been appointed City Engineer of Norwich, N. Y., to succeed C. E. Harris, resigned, as noted elsewhere.

C. E. Harris has resigned as City Engineer of Norwich, N. Y., in order to devote his whole time to private practice. He will continue to make Norwich his headquarters.

Joseph E. Love has resigned as Engineer of the South Dakota Railroad Commission and is now connected with the engineering department of the Chicago Union Station Co., Chicago, Ill.

C. E. Herth, recently Assistant Division Engineer of the Baltimore & Ohio Southwestern R.R., at Seymour, Ind., has been promoted to be Division Engineer of the Illinois division at Flora, Ill.

E. J. Correll, Division Engineer of the Baltimore & Ohio Southwestern R.R., at Chillicothe, Ohio, has been promoted to be District Engineer of Maintenance-of-Way, with office at Cincinnati, Ohio.

James R. Baldridge, Assoc. M. Am. Soc. C. E., formerly in charge of the estimating division of Irwin & Leighton, Philadelphia, Penn., is now Manager of the Philadelphia office of the F. W. Mark Construction Co.

Nathan C. Wyeth, an architect of Washington, D. C., has been appointed to assist the Corps of Engineers, U. S. A., officers in the design of the Key Bridge across the Potomac River to replace the old Aqueduct bridge.

W. R. McCann, M. Am. Inst. E. E., recently private secretary to William A. Shaw of the Illinois Public Utilities Commission, has been appointed Valuation Engineer of the Commission. For several years he was an assistant to Edward Schildhauer, Electrical and Mechanical Engineer of the Panama Canal.

Cecil Hamelin Taylor, M. Am. Soc. M. E., Consulting Engineer of the Republic Motor Truck Co., Alma, Mich., and of the Curtis Aëroplane Co., Hammondsport, N. Y., has left this country for England and France, where he will study aëronautical developments and gasoline motor improvements since the outbreak of the great war.

Roy M. Green has been appointed Assistant Professor of Highway Engineering at the Agricultural and Mechanical College of Texas. He is a graduate of the University of Nebraska and of the course in highway engineering at Columbia University. Recently he has been Testing Engineer and Superintendent of Pavement Construction with Clarke E. Mickey, Consulting Engineer, Lincoln, Neb.

OBITUARY

John Millen, President of the Duluth & Northern Minnesota Ry., died at his home in Duluth, Minn., July 27, aged 67 years.

Emil Swanson, an engineer in the Department of Water Supply, Gas and Electricity of the City of New York, died at his home in Brooklyn, Aug. 9. He was born in Sweden 44 years ago.

Will Christy, Vice-President of the Northern Ohio Traction and Light Co., a prominent banker and capitalist of Akron, Ohio, died Aug. 9. Mr. Christy is given credit for the formation of the Cleveland Construction Co., which built electric railways in many parts of Ohio and Canada.

A. B. Stickney, former President of the Chicago Great Western Ry., died Aug. 9, at his home in St. Paul, Minn., aged 76 years. He was born in Maine in 1840. He was educated and practiced as a lawyer. In 1871, while living in St. Paul, he gave up his law practice to engage in railway promotion. He subsequently took an active part in the railway development of the Northwest and was President of numerous companies, including the Chicago Great Western Ry.

William B. Upton, M. Am. Soc. M. E., whose death was briefly noted in the obituary columns of last week, was for many years a resident of Washington, D. C., and was well known there. He was born in San Francisco in 1856 and was once connected with the Union Iron Works there. Some of the work with which he was connected in Washington was the supervision of construction of the cable-car tracks in Pennsylvania Ave., which he subsequently reconstructed to underground contact electric trolley tracks. He also had charge of electric street railway construction in Tacoma, Wash., and Kansas City, Mo. He is survived by a widow and one son, William Upton, of the United States Geological Survey.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The New England Water-Works Association at its 35th annual convention to be held Sept. 13 to 15 in Portland, Maine, plans to issue an advance catalog of the different appliances and materials to be shown by the exhibitors. Exhibits should be shipped to Charles R. Harris, secretary Exhibit Committee, care of Portland Water District. About 60 spaces have been contracted for by the association and practically all have been spoken for.

The International Irrigation Congress will meet for the 23rd time Oct. 14 to 18. The opening session will be held at the Elephant Butte Dam, which is to be dedicated on Oct. 14. Following this session, there will be the regular business sessions which will be held in El Paso. The secretary is Arthur Hooker, El Paso, Tex.

The National Parks Highway Association was recently organized at Yellowstone, Wyo., with Gus Holmes, president, and L. L. Newton, of Cody, Wyo., secretary. Vice-presidents were elected as follows: For Montana, H. J. Miller; Wyoming, W. A. Deming; Colorado, T. J. Hall; Oregon, Frank C. Riggs; Idaho, Carl Davis.

The American Railway Bridge and Building Association will hold its annual convention in New Orleans Oct. 17 to 19, with headquarters at the Gruenwald Hotel. The Supplymen's Association will meet at the same time.

Appliances and Materials

Railway Ditcher with Three Sets of Engines

A light revolving steam shovel for railway ditching work, having as one of its special features the use of separate engines for the swinging and traveling movements (independent of the main engines), is built by the Browning Co., Cleveland, Ohio. This arrangement is stated to increase the speed and efficiency of operation, as the three sets of movements can be made simultaneously. Thus the machine can be swung while the load is being lifted, and it can be swung and moved forward while the bucket is being returned for a fresh cut. In ditching work the machine travels on a track laid upon the cars of the work train, moving along as it loads the cars.

For the operation of the bucket lines and boom topping-lift there is a double-drum main engine with vertical inverted cylinders 6x8 in., the cylinders being mounted on opposite sides of the frames carrying the cable drums. For swinging, there is a two-cylinder 5x5-in. horizontal engine, geared to a vertical shaft that carries the pinion engaging the circular rack on the underframe. Alongside of this is a similar engine that operates the propelling gear. The entire operation is under the control of one man, who is stationed at the forward end, where he has a clear view of the work. The accompanying view shows the ditcher mounted on its track on a steel-frame flat-car of the Rutland R.R. The equipment includes a large vertical boiler, a 520-gal. water tank and a 1,500-lb. coal bunker.

The axles are fitted with two sets of wheels. On their outer ends are wide double-flanged wheels having a broad tapered tread outside of the outer flange. These provide for carrying the machine on two sets of rails, those on each side being spaced 4½ in. c. to c. and giving a total gage of 7 ft. 4½ in. c. to c. of outer rails. This gives ample stability. If only one rail is used on each side, the rails for each new length of track may be laid inside (or outside) of those on which the truck is standing, and lapping beyond the ends of the latter. This is shown in the accompanying view, in which the rear wheels have the inner tread riding on the rear section of the track, while the front wheels have the outer tread upon the rails of the forward section of track. Upon the same axles (but inside the truck frame) are flanged wheels for running on standard-gage tracks.

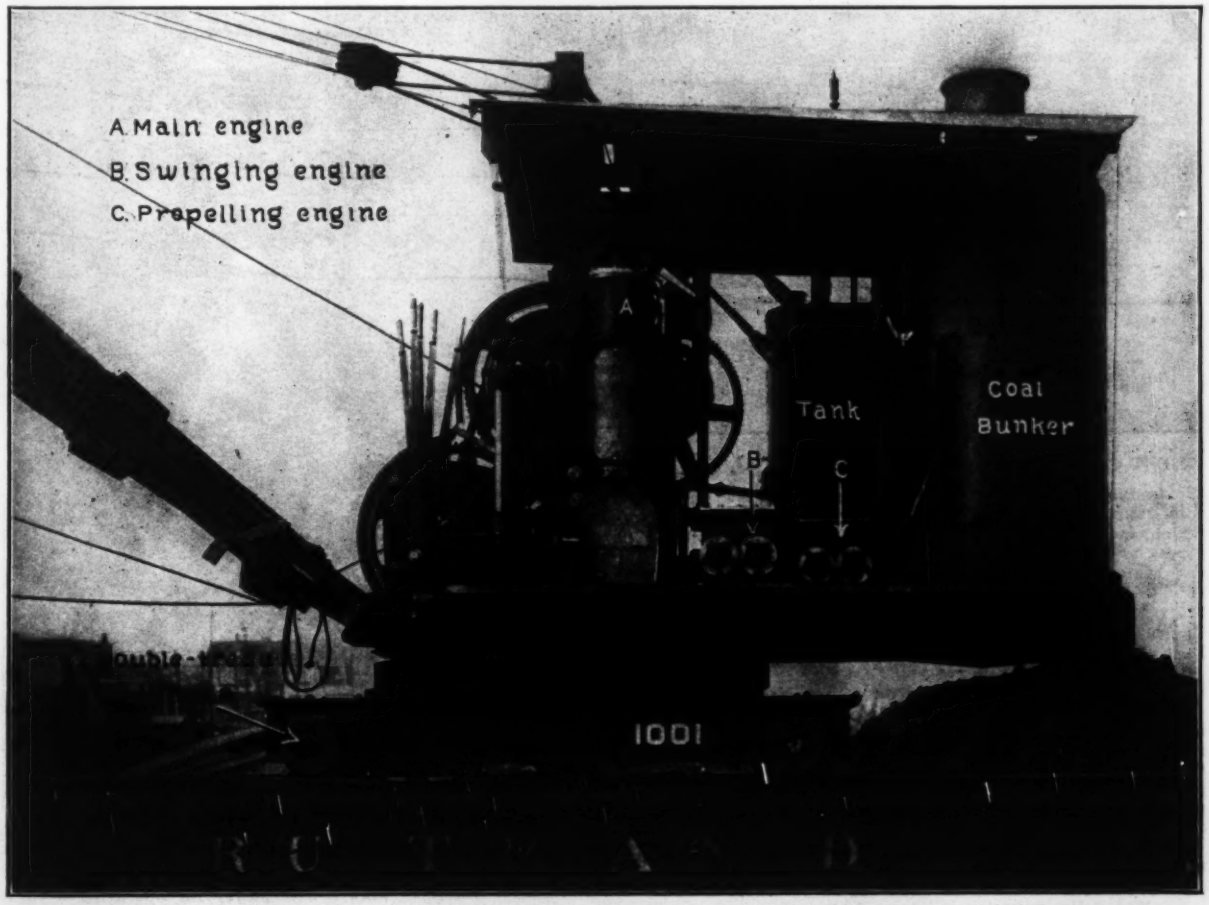
The boom is 26½ ft. long. The dipper is of ⅝-yd. capacity. When mounted on a flat-car having its floor 4 ft. above the rail, the machine has a maximum height of 18 ft. from track rail to lower edge of dipper door when open, and will cut to a depth of 5 ft. below the track rails.

This machine can be operated also as a dragline excavator or as a locomotive crane, its lifting capacity in the latter case ranging from 4,500 lb. at 30-ft. radius to 7½ tons at 10-ft. radius. Its weight as a ditcher is about 28 tons.

* * *

Improved Steam-Boiler Covering

A new boiler-wall coating, called the "J-M Aertite," has recently been put on the market by the H. W. Johns-Manville Co., of New York City. It is designed to be easily applied by trowel, to be adhesive and flexible. It forms a continuous rubbery blanket over the whole setting. A ⅛-in. thickness is recommended, for which 25 to 40 lb. per 100 sq.ft. is required.



RAILWAY DITCHER WITH INDEPENDENT ENGINES FOR BUCKET, SWINGING AND PROPELLING MACHINERY

Another Anti-Corrosion Iron

Another iron alloy suitable for castings, to be used in chemical works and where it is desired to avoid rusting or attack by acid and alkali reagents, is being made by the Pacific Foundry Co., Harrison St., San Francisco, Calif. The trade name is "Corrosiron." It is claimed that it can be cast in intricate shapes and can be readily machined.

* * *

Wagon-Loader with Belt Conveyor

For loading stone and gravel from railway cars on supply sidings into wagons for distribution to road or concrete work a portable belt-conveyor device has been introduced. A shallow pit beneath the track accommodates the horizontal end of the belt and this pit is covered with a platform having three rectangular openings with sliding doors. These doors are operated by levers, and serve to regulate the feed to the belt. The upper end of the inclined portion of the conveyor is high enough for wagons to be driven under it. The belt is 16 in. wide and is carried by troughing rollers on a pair of inclined timbers mounted on the sills of a wagon bed. The timbers of the horizontal portion of the belt are hinged to the inclined timbers so that this portion of the belt can be folded up. On the wagon bed is the 4-hp. gasoline engine which operates the belt and runs continuously. A clutch is placed at the head of the inclined frame, so that each driver can start the conveyor when his wagon is in position, and stop it when the wagon is loaded. The speed of the belt is 225 ft. per min., giving a delivery of about 1 cu.yd. per min. The machine is easily hauled from place to place by a team. It is built by the Burch Plow Works Co., of Crestline, Ohio.

BELT CONVEYOR FOR LOADING STONE AND GRAVEL

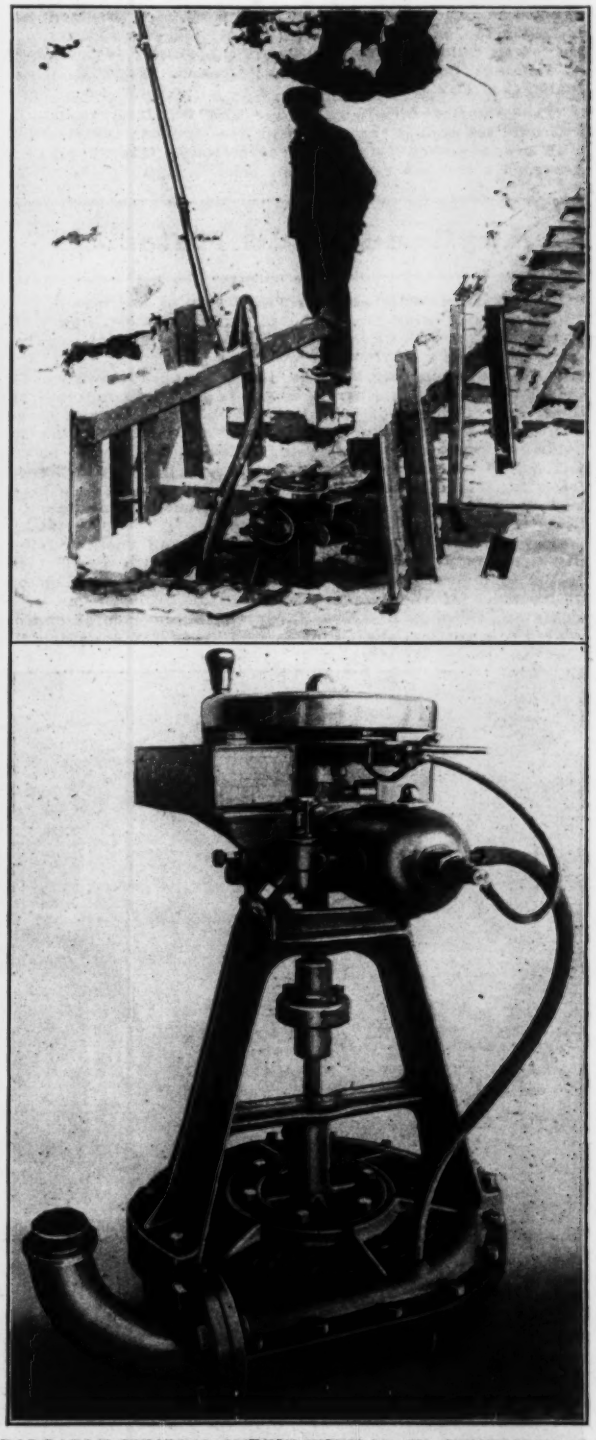
* * *

Portable Pumping Outfit for Construction Work

A portable pumping outfit with centrifugal pump was used to supply water in building a large country residence for A. A. Schlesinger on the upper Milwaukee River, about 6 mi. from Milwaukee. As shown in Fig. 1, the pump was placed in a wood tank or sump in the river. The delivery pipe was carried up the river bank to an elevation of 35 ft. and then along the ground for about 600 ft. to the site.

The outfit has a vertical-shaft pump (Fig. 2) with gasoline motor mounted upon it. The pump is about 15 in. in diameter, with 2-in. suction and 1½-in. discharge. With a 2-hp. motor the capacity is about 2,400 gal. per hr. against a 25-ft. head, while with a 3½-hp. motor the same capacity is given against a 40-ft. head. The oil and gasoline are mixed in the engine tank, so that no attention is required for cylinder lubrication. The outfit requires a floor space of only 17½x24 in. and is 27 to 33 in. high. Its weight is about 133 lb.

A similar outfit has been used in sinking foundation shafts. The pump can be disconnected and the shaft geared to a horizontal shaft carrying a belt pulley for operating a light saw or other tool. These pump and propeller outfits are built by the Evinrude Motor Co., of Milwaukee, Wis.



PORTABLE PUMPING OUTFIT WITH 1½-IN. CENTRIFUGAL AND 2-HP. GASOLINE MOTOR